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Editorial

After many years of neglect wildlife in our country is now receiving the attention that it deserves from both the Central and State Governments, and serious field studies have been undertaken by foreign and Indian naturalists on some of our wild animals.

Recent articles in our Journal have reflected this encouraging trend, and among these we would like to refer especially to those by Stephen Berwick **68** (2) ; Schaller **66** (1), **67** (3).

In this context we are particularly happy with the Report by Mr. Krishnan on the Larger Mammals of Peninsular India which is appearing in the current issues of the Journal, and we would like to compliment the Jawaharlal Nehru Memorial Fund again for sponsoring this Survey. Krishnan is a meticulous observer as his Report indicates and from the beginning of the Survey he had decided that his photographs should provide incontrovertible proof supporting his observations. The fact that we have been able to reproduce the photographs with the text is due entirely to the generous financial grant which we received from the Seth Purushottamdas Thakordas and Diwaliba Charitable Trust. We also intend to publish this Report as a separate after it has been serialised in the Journal.

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1972 APRIL Vol. 69 No. 1

On the Southern Racket-tailed Drongo *Dicrurus paradiseus paradiseus* (Linn.)

BY

K. K. NEELAKANTAN

(*With eight figures in a plate*)

While preparing a paper on the birds I had observed at Dharmadam, Cannanore District, Kerala State, I found that I had more data on the Racket-tailed Drongo than could go into such a paper. Hence this note. It is not based on any systematic study of the bird and contains little more than tentative conclusions which have to be verified by more thorough investigation. It is published in the hope that it may induce some one with more skill, time and facilities to undertake a full-fledged biology of the Racket-tailed Drongo which, though a favourite of every bird-watcher who knows it, has failed to meet with its Boswell.

These observations cover a period of 20 months : 21-x-1968 to 25-vi-1971, two breeding seasons roughly. My house was at the southeastern corner of the territory of one pair. It was, therefore, often visited by other pairs—at least three of them. The pair that held territory on the northern side of my house raised 1 young in 1969 and (they or their successors ?) raised 2 young in 1970. In 1970 three other pairs that occasionally visited our compound appeared to have only 1 young each. Of the total of 5 juveniles seen, one had a small tuft of white feathers on the chin and rough crescent marks in white on the undertail coverts. The others had no touch of white anywhere at any time.

Relationship with other birds

The tendency of this drongo to associate with Tree Pies and other species to form ' mixed hunting parties ' is well-known. This sociability seems to be of advantage more to the drongo than to other members of the party. Though the drongo's alertness and habit of breaking out into loud calls on the approach of an enemy may be of help to the other birds, it was found that quite often the drongo raised false alarms by mimicking the shikra.

The drongo behaves like a bully and regularly tries to snatch off prey that has been spotted by some other bird. The drongo watches the larger members of the party such as Goldenbacked Woodpeckers, Tree Pies or Jungle Babblers, and when one of them is about to capture an insect the drongo swoops down with a sharp whistle or screech and snaps up the prey. Among the victims of the drongo's tactics were the Common Myna, the Green Barbet, the Jungle Babbler, the Tree Pie, the Blackheaded Oriole, the Indian Oriole, the Goldenbacked Woodpecker and the Iora (the last only when a pair was foraging busily to satisfy the demands of an insatiable juvenile Banded Bay Cuckoo). Juvenile Racket-tailed Drongos often kept close to a party of Jungle Babblers, snapping up insects disturbed by their activities. But the juvenile drongo, unlike the adult, seldom robbed the babblers of their legitimate prey.

When Jungle Crows pecked at ripe cashew and mango fruit on the stalk, adult Racket-tailed Drongos regularly followed them, sat on some perch below the crows' and snatched up tiny morsels that the crows let fall. This sort of thing at times led to the drongo's chasing the crow from tree to tree.

Though on a few occasions Racket-tailed Drongos have been seen harrying the Jungle Owlet, the Tree Pie and the Goldenbacked Woodpecker, it was never found pursuing crows and kites (Brahminy & Pariah) as nesting Black Drongos invariably do. The Shikra seems to be the only creature whose presence seriously upsets the Racket-tailed Drongo. The appearance of a Shikra in their neighbourhood is greeted with a special alarm-cum-aggression note : a loud ' kwei-kwei-kwei . . . sheecuckoo-sheecuckoo-sheecuckoo-why ! ' Yet in 1969 and 1970 a pair of Shikras nested only a few hundred yards away from the tree where I suspect the drongos themselves were nesting.

Only twice did I observe a Racket-tailed Drongo actually chasing a Shikra. At 5.20 p.m. on 1-vi-1969 two adult drongos were on different trees close by. Suddenly one of them burst out screaming ' shweecuckoo-shweecuckoo-why ! ' over and over again. A Shikra flew out of another tree and started soaring, with the drongo in hot pursuit. The drongo went on screaming ' sheecuckoo-sheecuckoo-why ', but whenever it dived at the Shikra it uttered a rasping ‘ shkre-shkre ’ note. Although the drongo flew above the shikra and repeatedly stooped at it, it never struck the Shikra. Compared with the Black Drongo, the Racket-tailed is a clumsy manoeuverer. When the shikra soared in small circles, the Racket-tailed Drongo seemed to be handicapped in its movements by the tail rackets.

On 23-vii-’69 at 8-10 a.m. a pair of Racket-tails pursued a female Shikra till the latter alighted on a 25-foot tree and sat with its wings and tail spread out. The drongos also alighted on a tree near by and went on uttering a low ‘ tu-tee-yoo . . tu-tee-yoo ’. After a few minutes the Shikra began preening and was left alone by the drongos. On 30-v-’69, however, a pair of adult drongos had repeatedly dived at a Shikra perched on a rock. The Shikra changed its perch 3 or 4 times, but the drongos persisted in their attack.

The loud ‘ shweecuckoo-shweecuckoo-why ’ (or ‘ khwoi ’) notes were never used in intraspecific territorial display. It seemed to be specially reserved for use against the Shikra. Though the Racket-tailed Drongo regularly mimics the Shikra’s ‘ ki-kee ’ to perfection, it never did so when a Shikra was present and was causing it some anxiety (See also the note under ‘ Mimicry ’).

Territorial Behaviour

Territorial behaviour was most prominent when young were present. Defence of territory was achieved largely by vocal demonstration. As a rule, one of the partners tackled the intruder(s) while the other remained with the young or led them away. If the intruders were persistent, the defender would alight close to the intruder and both birds would bob up and down, bow stiffly, take short leaps on the perch, and utter all sorts of whistles, screeches and chattering notes. There would be much shuffling of wings and flirting of tails too. If, as often happened, the intruder flew off the perch, the defender would at once give chase. If the intruder flew out of the territory, the defender would return to its mate and they would go on calling loudly for a while (For call notes uttered in territorial display, see under ‘ Voice ’).

Courtship

As most of my observations were rather casual and restricted normally to the hours between 7 and 8 a.m. and 5 and 7 p.m. (except on Sundays and occasional holidays), I could have missed much of the birds’ displays. Only on 4 occasions did I notice anything that could have been part of the Racket-tailed Drongo’s courtship display. They concern the behaviour of the pair that held sway over the wooded area north of our house. One of the partners had the racket-feather on the right side missing. This shall be referred to as LRD in later paragraphs. Its mate had not lost either racket and shall be referred to as BRD.

On 21-iii-1970 at 4.30 p.m. LRD was on a thin branch. The bird suddenly stiffened, held its tail out horizontally, and started trembling all over with the single racket-feather bobbing up and down, inevitably. The wings were kept closed. BRD at once flew to the same branch, sat close to LRD, leaped a couple of inches and smartly turned about. This it repeated once again so that both birds faced the same direction. LRD then flew to another branch and repeated the ' display '. BRD at once followed and sat close to LRD, but did not leap up or react in any other way. Soon after this they flew off. No mating was noted. They were back by 5 p.m. and I watched their movements till 6.15. There was no repetition of the ' display ' ; but once LRD picked up a slender broken twig, held it in its bill and played with it for some time before dropping it. 15 minutes later it flew down to the ground, picked up another thin twig, kept it in its bill for a time, dropped it and then flew back to the tree.

The next day (22-iii-'70) I watched the pair closely from 4 to 4-45 p.m. At 4 p.m. another pair (of which neither had lost a tail racket) flew into the compound and was at once chased away. At 4-30 LRD suddenly raised its tail, held it horizontally, and started quivering. BRD was then just a foot or two away, but ignoring this ' display ' it flew down to pick up an insect and flew to a tree farther off.

On 8-iv-'70 at 4-35 p.m. LRD and BRD were close together on a slender branch some 12 feet above the ground. LRD was holding its tail stiffly and horizontally, shaking all over and fluttering its wings too. BRD was also quivering, but it did not hold its tail horizontally. BRD then leapt upon the other's back. But LRD sidestepped smartly and hopped off a short distance. This sort of thing was repeated half a dozen times. I do not think that coitus was effected. The birds were curiously silent all the while. Every time BRD tried to tread the other, it attempted to seize the feathers on LRD's nape. LRD finally flew off to a hedge-like row of bushes 30 feet away and alighted on a slender horizontal branch at the top of a ' ramphal ' (Bullock's Heart, *Annona reticulata*) sapling. There it proceeded to strip the branch of all its leaves (all new shoots, tender and emerald green) letting them fall to the ground as soon as they had been plucked. When the entire twig, some 3 feet long, had been fully stripped of every bud and leaf, LRD flew to another branch which was bare but for two large, brown leaves. These, too, it deliberately plucked and dropped. Just then BRD flew towards LRD and both of them flew off. (LRD's behaviour reminded me of the way a chained dog pulls down whatever is near at hand when its pleas for freedom are ignored !) This was probably an instance of ‘ displacement activity ’.

On 23-iv-’70 my wife saw the same pair behaving as described in para 2 of this section.

VOICE

The Racket-tailed Drongo’s repertoire of call-notes is so large and varied that I have listed below only those that were uttered fairly regularly or seemed to have special significance.

These calls are broadly divisible into two groups : whistled notes and metallic notes.

A. Whistled notes.

1. shwoooi-shwoooi-shwoooi—a very human whistle.
2. a hollow ‘ shwoooo-shwoooo-shwoooo ’ such as may be produced by blowing hard into the mouth of a narrow-mouthed ink bottle.
3. kwei-kwei-kwei. . . .
4. kwi wi wi wi wi wi wi. . . .
5. a soft low whistle, ‘ chēw-yee-yóu . . chēw-yee-yóu ’
6. chēw-chēw-chú-chú-chú-chú-chēw
7. chī-chéop, chī-chéop, chīp-chéop. . . .
8. itleeyou-itleeyou. . . .
9. tree-tree-pew-pew-pik-pik . . . tree-troi-pew-pew-pik. . . .
10. tlrēēn-tlrēēn-tlrēēn-chō
11. troi-troi-troi- tititititititi
12. chip-chip-chip-whiwhiwhiwhiwhiwhiwhi
13. shwip-shwip-shwip-titititititititi
14. terōclee, terōclee, terōclee. . . .
15. chiokli, chiokli, chiokli. . . .
16. tik-tik-tik--chēē-chō
17. whip whip whip whip whip whip . . .
18. itlyowō, itlyowō, itlyowō . . . .
19. piteeyoo-piteeyoo-piteeyoo
20. toi-toi-toi-toi-toi-toi-toi

No. 19 seemed to be a ‘ contact note ’. It was often uttered by the adult on flying away from where it had been with the juvenile.

No. 20 always reminded me of Sálim Ali’s description of the call of the Drongo-Cuckoo (*Surniculus lugubris*) ‘ . . . 7 or 8 short, musical whistling notes as if the bird was actually counting 1-2-3-4-5-6 &c. The notes rise in scale and end abruptly.’ Though I have seen the Drongo-Cuckoo at Dharmadam itself, I have not so far heard its voice. It is probable that No. 20 was a mimicked note.

B. Metallic, bell-like notes.

1. tilōnk-tilōnk-tilōnk . . (a loud, ringing note, as of a hammer striking a hollow iron pipe)—perhaps the loudest of the drongo’s notes.
2. tloink-tloink-tloink. . . .

3. troing-troing-troing. . . .
4. treeeyong-treeyong-treeyong. . . .
5. kleerung-kleerung-kleerung. . . .
6. kitleerong-kitleerong-kitleerong. . . .
7. shklroeng-shklroeng-shklroeng. . . .
8. kwikliong-kwikliong-kwikliong. . . .
9. chewling-chewling-chewling. . . .
10. kli,kli,kli,kli, kwikling-kwikling-kwikling. . . .
11. kwikwikliong-kwikwikwikliong. . . .
12. rotten-tree, rotten-tree, rotten-tree. . . .

Combinations of A and B are not at all uncommon. For example :

whip-whip-whip-itleeyong-itleeyong
& tloo-whit, tloo-whit, tloo-whit . . . .

A note uttered fairly regularly after sunset and often early in the morning was ' chooo-choóp, chooo-choóp, chooo-choóp '. In the evening these were often the last notes uttered, and were often preceded by a period of silence.

Almost all the notes listed above used to be uttered when rivals met, but their use was not restricted to such contexts.

Pre-Dawn song

Sálim Ali (in his BIRDS OF TRAVANCORE & COCHIN, 1953) drew attention to the Racket-tailed Drongo's habit of calling loudly long before sunrise : ' On the approach of the breeding season the birds become excessively noisy, beginning as early as 4 a.m. in moonlight and keeping up a continuous metallic *tunk-tunk-tunk-tunk*, etc. at the rate of about two *tunks* per second, for two hours, or more, almost till sunrise. Several birds chime in from different quarters.'

My notes on the drongo's pre-dawn performance are extremely scrappy as I do not share the drongo's enthusiasm for early rising. Two extracts from my notes follow :

(1) On 4-iv-'69 by 4 a.m. the calls had begun. They stopped at 5-30. Four different sets of notes were uttered, each repeated many times in series :

(*a*) a bell-like tonk-tonk-tonk-tonk . . . .
(*b*) a plaintive pio-pio . . pio-pio . . pio-pio . .
(*c*) a ringing choink-choink-choink . .
and (*d*) a lower trink-trink-trink-trink . .

After running through this set of notes, the bird started again though the order in which notes (a) to (d) were repeated varied.

(2) On 14-iv-'69 I was up at 5-15 a.m. The drongo started calling at 5-30. It began with a series of ' pio-pio ' notes. After a spell of silence came a ' wheeew-wheew-wheew ' whistle, followed by a rapid, metallic trinki-trinki-trinki. The bird stopped calling at 6 a.m.

As March-April appeared to be the nesting period, the 'earliest' date on which I heard the pre-dawn 'song' is 6-xii-'69, and the 'latest' 19-vi-'69. The two dates relate to two different breeding seasons.

Mimicry

The mimicked note most regularly uttered by the Racket-tailed Drongo was found to be the 'kki-kee . . kki-kee' call of the Shikra. Among the Dharmadam birds, at any rate, the next in favour was the 'pyo-pyo . . pyo-pyo' of the Brownheaded Storkbilled Kingfisher. This seemed at times to mislead the kingfisher itself. For on 1-iii-'70 at 8 a.m. a Racket-tailed Drongo that was continuously uttering the 'pyo-pyo' call was approached by a Storkbilled Kingfisher. This bird came flying low and passed close over the head of the drongo. It alighted on a coconut tree some 150 yards away and went on calling. I noted, however, that while the kingfisher regularly repeated the 'pyo' sound thrice, the drongo repeated it only twice.

Among other birds mimicked by the Racket-tailed Drongo were the Jungle Crow, the Brahminy Kite, the Koel, the Blossomheaded Parakeet, the Indian Tree Pie, the Blackheaded Oriole, the Iora, the Orange Minivet, the Jungle Babbler, the Whitebreasted Kingfisher and the Crested Serpent-Eagle. But for the last, all these birds were heard either seasonally or throughout the year at Dharmadam. Only the 'hweer-hweer-hweer' of the Serpent-Eagle was never heard by me though the sight of one or more Serpent-Eagle-like birds soaring about was not uncommon.

The only mammals whose voice the drongo mimicked were the cat and the palm squirrel. The mewing of the cat was generally mimicked only when the drongo saw a cat passing or skulking in the bushes.

Most of these mimicked notes were normally uttered in an undertone when the drongo was alone and resting. Therefore they seemed to be part of a sub-song.

With regard to the squirrel, the drongo chose to mimic only its alarm call.

The ability to mimic seemed to be developed early in life. A juvenile drongo first seen on 15-vi-'69 was first heard uttering adult notes on 27-viii-'69. On the same day it was heard mimicking the mewing of the cat and the harsh, nasal, one-syllabled note of the Blackheaded Oriole.

The Juvenile's Food-call

For some weeks (6 to 8 ?) after leaving the nest the juvenile utters only a low, harsh 'chre-chre-chre'. This food-call resembled rather closely the food-call of the juvenile Indian Tree Pie. For many weeks a family party of Tree Pies and another of Racket-tailed Drongos used to be found together, often with various other birds (in mixed hunting parties).

RACKET FEATHERS

Moulting of the Adult's Racket-Feathers

My observations suggest that the racket-feathers of the adult moult asymmetrically. Adults with one or the other of the tail-rackets missing begin to be seen regularly in February. The first adult without either of the racket-feathers was seen on 11-viii-'69. In September most adults were without racket-feathers. Of breeding pairs seen in March, April, and May, one partner almost invariably had one racket missing while the other had both intact.

Whether the racket-feathers were accidentally lost or dropped in the normal course of moulting could not be discovered. Both in 1969 and 1970, in the pair resident near my house it was a bird that had the right-side racket missing that seemed to be most attached to the young. In both years the bird's mate retained both the racket-feathers till June or later. This single-racket bird of the pair observed in 1969-70 was evidently the female.

The replacement for the shed racket-feather appears first, so that a bird identified as a 'left-racket bird' becomes later a 'right-racket' one! Some of my notes look very confusing now because of this. Though the time gap between the loss of the two racket-feathers was often very long, that between the dates of their replacement is short. By the end of December most adults seem to have both racket-feathers fully developed.

A well-grown juvenile and an adult with developing racket-feathers can be distinguished without difficulty. For while in the juvenile these bend outwardly, in the adult they always bend inwards (See fig. H). Moreover the racket-feathers of the juveniles are of equal length at all times, while those of most adults with developing racket-feathers are almost invariably of different lengths.

Development of the Juvenile's Racket-Feathers

In 1969 the pair that held territory north of my house raised only one young and, since no other juvenile bird was seen in the area, I was able, roughly, to note the development of the juvenile's tail.

This juvenile was first seen on 15-vi-69 when it was presumably 4 or 5 weeks old[1]. At first sight it seemed to have a tail like the bulbul's.

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[1] It had a distinct, but short, crest. Its plumage was not as glossy as that of an adult. The bill was horny blackish with a whitish tip ; mouth pale flesh colour; gape mark pale pink.

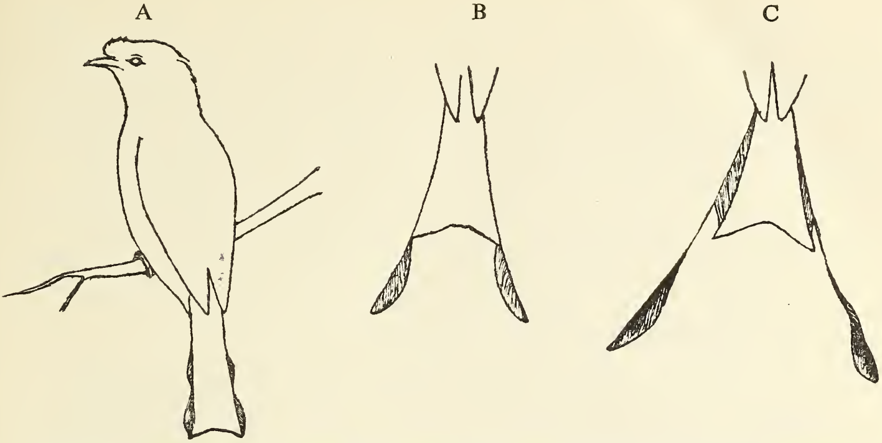

Fig. A. Juvenile bird when first seen on 15-vi-'69; Fig. B. Tail of the same juvenile as on 6-vii-'69; Fig. C. Tail of the same juvenile as on 12-vii-'69.

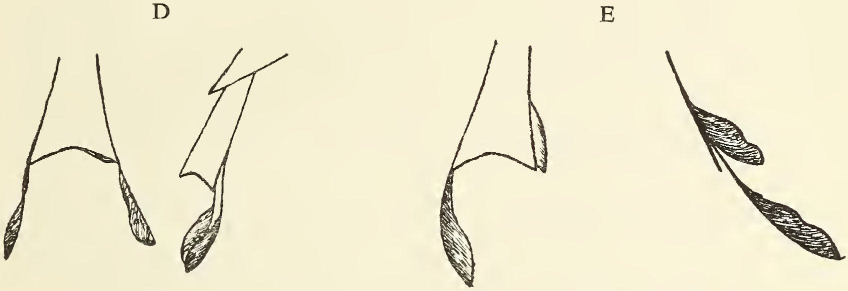

Fig. D. Tail of another juvenile (dorsal and ventral views) as on 26-vi-'70; Fig. E. Tail of one adult (dorsal & lateral views) as seen on 24-ix-'70. The straight line represents the 'normal' rectrices.

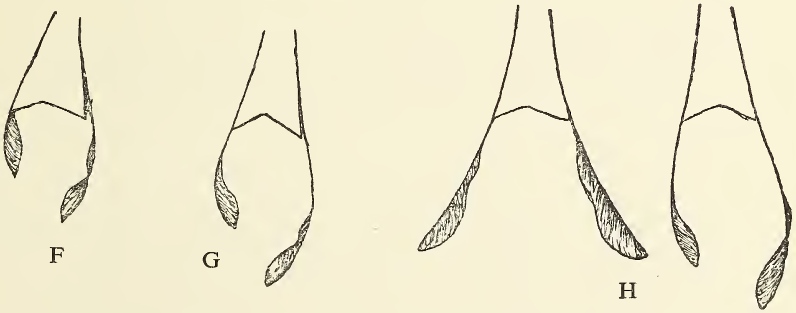

Fig. F. Tail of an adult as seen on 6-x-'69; Fig. G. Tail of the same adult as on 3-xi-'69; Fig. H. Tail of the juvenile (of Fig. D) and that of one parent as on 8-xi-'69.

N.B. The diagrams are based on sketches made 'in the field' on the dates given below them. All except those on the right side in Figs. D & E are dorsal views. All the diagrams are not drawn to the same scale. The shaded portions indicate the racket-feathers.

But a closer look revealed that the racket-feathers were present, and equal in length to the nearest rectrices. These did not lie flat, so that, viewed from a side, the tail appeared thick (see fig. A). Juvenile birds of the next season also, when first seen, had tails exactly like this.

By 26-vi-'69 the tips of the racket-feathers were projecting half an inch beyond the tips of adjacent rectrices.

On 6-vii-'69, when the juvenile's mouth was still pink, the tail had the shape shown in fig. B. Fig. C shows the tail as on 12-vii-'69.

A TENTATIVE SUMMARY OF THE LIFE HISTORY

Racket-tailed Drongos apparently pair for life.

They seem to be attached to their territory throughout the year.

The territory of one pair appeared to cover half a square mile of well-wooded country.

The breeding season (in the sense of ' the period of the year during which birds of a given species mate, build their nests, lay their eggs, and raise their young '—NEW DICTIONARY OF BIRDS, 1964, p. 106) seemed to stretch from March to September, though young birds could be seen with their parents till about December.

What is presumed to have been courtship display was observed in March and April.

Birds seemed to nest, lay eggs, and tend the pulli during March and April mainly.

Young ones apparently left the nest in the middle of June.

They accompanied their parents closely and were fed by them (with decreasing frequency and regularity) till about September, though even in July they could find food independently.

The family bond appeared to be maintained till mid-December.

By the middle of February the young seemed to disperse.

Colour vision in an Indian Fish *Anabas testudineus* (Cuv.)

BY

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(*With two text-figures*)

Although electro-physiological techniques have largely been employed to explore retinal mechanisms for analysing light in terms of its wavelength direct evidence for hue discriminatory capacity of animals comes mainly from training experiments. This method dates back to 1901 when Zolotnitzky fed fishes on red midge larvae and later successfully lured them with bits of red yarn. Since then experiments have been devised to eliminate luminosity as a factor in colour discrimination either by using finely graded series of coloured papers or by altering the intensity of light transmitted through coloured filters.

Results obtained through behavioural experiments on colour vision are not sufficient, and as such we are still far away from understanding the colour vision system in fish. In our investigation into colour vision the Indian perch *Anabas testudineus* (Cuv.) has been selected for some important reasons. The fish possess accessory breathing organs and can be kept alive in aquarium for a long time without food and without changing water. They can be easily trained to feed from glass tubes. A notable behaviour of the fish is that during monsoon they leave water and move on land (Day 1958).

This fish was, however, successfully trained to discriminate red from green, blue, yellow, grey and violet. It also discriminated violet from blue, green and grey, as well as green from blue. We have, therefore, come to the conclusion that this fish does possess some mechanism for colour vision, and it is mediated through trichromasy.

METHODS

Two groups of fish, each consisting of four individuals, were trained separately to feed from glass tubes. The fish, measuring 9 to 11 cm in length, were purchased from the local market. Their sexes could not be determined because of absence of secondary sexual characters.

Group-I was first conditioned to respond to red as the positive stimulus with blue, green, yellow, grey and violet as the negative. It was later conditioned to violet as the positive stimulus with blue, green and grey as the negative. Group-II was trained to discriminate between blue and green, the latter being the positive stimulus.

Glass tubes, used as colour stimuli, were first wrapped with coloured paper and then covered with thin transparent polythene sheet to make them water-proof. Ten shades of every colour tested were selected from homogeneously coloured poster papers.

A small piece, about 1 cm long, of fresh earthworm *Pheretima* sp., was stuck to one end of the tube, and it was covered with a thin piece of black rubber to check direct visual stimulus of food. The negative stimulus had a similar arrangement but was without any food. Once the fish had learnt to associate food with a particular colour, both the tubes were furnished with food, thereby controlling olfactory and gustatory cues.

During each trial a pair of colour stimuli were offered, and if the fish could snap at the right tube directly one positive response was counted. Twenty trials were performed on every daily session. Twenty combinations of colour pairs were selected at random from twenty shades of colours and presented at random with respect to relative position of tubes. The fish were light-adapted by an initial illumination of white light before start of every session.

On the last session of one discrimination test (red versus violet) coloured papers were replaced by spectroscopic filters of similar colour pairs. Glass tubes, covered with white paper, were bathed in the transmitted light. The intensity of light was altered by the use of neutral filters in the light path. Spectral transmission factors of red and violet filters, used in this experiment, are given in Fig. 1.

RESULTS

The fishes were successfully conditioned to respond correctly to coloured papers as well as to light of different wave-lengths focussed on white paper. The average scores, obtained in daily sessions with each of the ten pairs of colours tested, are presented in Table I. Results of the first seven sessions of pre-training with both Group-I and Group-II fishes are not given because the number of trials and responses was not constant during this period.

Filters were used on the 7th session of red (+) versus violet (−). The average score with filters is not much different from that with coloured papers. But the fish were very much confused and almost non-responsive to either of the paired stimuli offered when light-intensities were very low and colours, reflected from tubes, were just recognizable by the human eye.

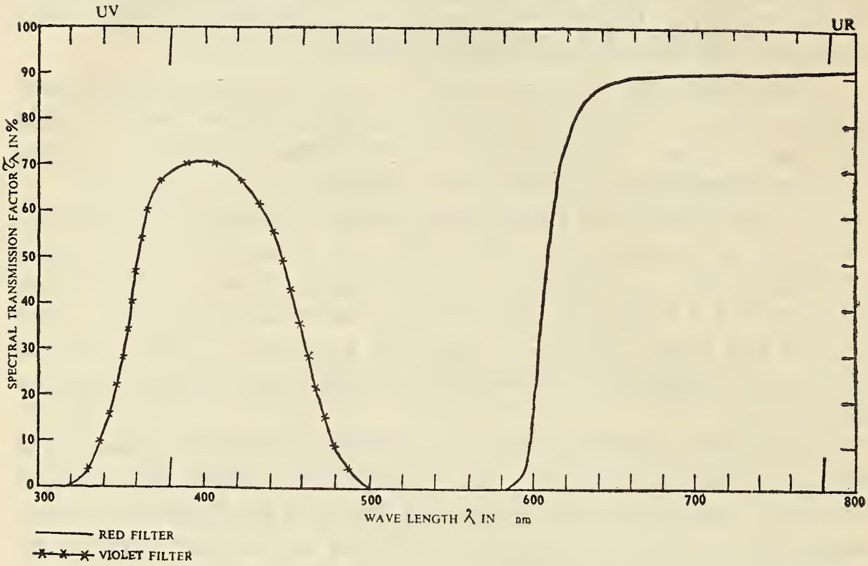

Fig. 1. Spectral transmission factors of red and violet filters.

Every daily session normally includes twenty trials. But on some occasions the fish were reluctant to respond to either of the paired stimuli offered. This happened when they were confused with the paired stimuli as well as towards the end of a session when the fish were relieved of acute hunger. Trials had to be increased in these cases to elicit twenty responses.

After thirty-six days' association with red as well as violet as the positive stimuli Group-I was deconditioned and blue was given as the positive stimulus with respect to red the negative. The gradual increase of positive responses for blue with simultaneous decrease in responses for red was transformed into percentage responses and plotted against days in Fig. 2. The two complimentary curves, the learning curve for blue and the deconditioning curve for red, show that after seven days the fish were deconditioned. Data-set I in Table I shows the average scores of the last seven sessions with blue (+) versus red (−).

Table I shows that the percentage of correct responses for all the colour pairs tested except red and violet varies from 83·35 to 96·85, which is fairly high and needs no further verification. The average scores with red (+) versus violet (−), obtained from six daily sessions excluding the 7th session with filters were statistically analysed by means of a t-test with a view to testing whether red and violet were really indistinguishable to the fish under investigation. Here t was found to be

TABLE I

AVERAGE SCORES OBTAINED BY TWO GROUPS OF FISH DURING EXPERIMENT

Days	Group-I									Group-II	Average
	Red (+)					Violet (+)			Blue (+)	Green (+)	
	A Green(−)	B Blue (−)	C Yellow (−)	D Grey (−)	E Violet (−)	F Blue (−)	G Green (−)	H Grey (−)	I Red (−)	J Blue (−)	
1	17·10	19·50	17·25	18·25	13·25	19·25	17·75	18·75	19·25	17·25	17·11
2	16·50	18·25	16·75	18·75	12·75	19·50	19·25	19·25	17·75	19·00	17·67
3	19·25	19·75	18·50	—	9·50	—	—	—	16·75	18·75	17·16
4	19·00	19·00	—	—	11·75	—	—	—	18·00	20·00	17·80
5	18·25	19·00	—	—	10·25	—	—	—	13·25	19·25	16·85
6	19·75	18·75	—	—	8·75	—	—	—	16·75	—	15·10
7	15·25	19·00	—	—	11·75	—	—	—	17·25	—	15·81
Average	17·87	19·03	17·50	18·50	11·11	19·37	18·50	18·50	17·00	18·85	16·78
Percentage	83·35	95·15	87·50	92·50	55·55	96·85	92·50	92·50	85·00	94·25	83·90

equal to 8·96 which is well beyond the 0·1% significance level of t with df 15, the latter being only 3·733. Thus it can be concluded that the fishes can distinguish between red and violet to some extent. The number of times they moved towards red as shown in data-set E in Table I is, on the average, significantly above 10.

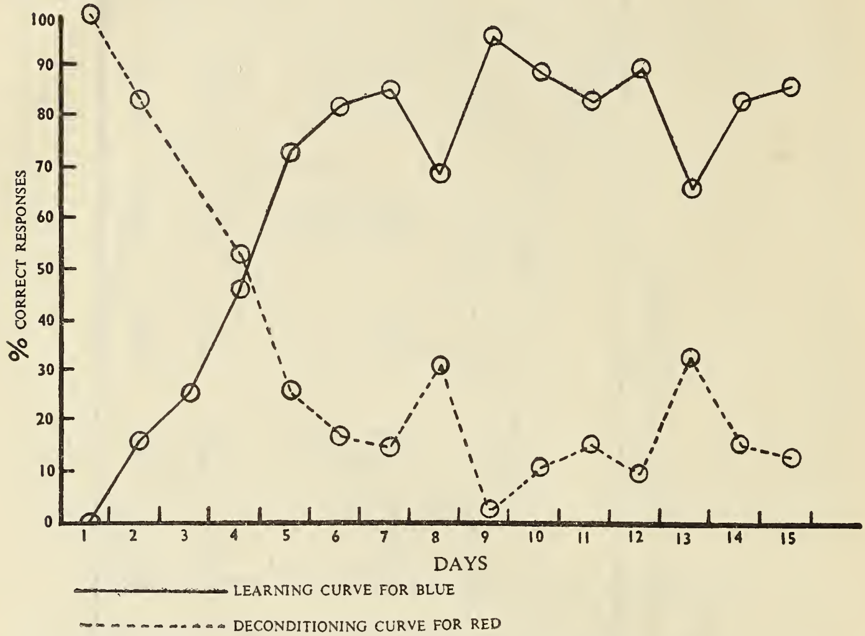

Fig. 2. Percentage responses for blue and red stimuli in relation to days.

When the positive stimulus was shifted from red to violet the fish immediately succeeded in making 92·50 to 96·85% correct responses in the discrimination of violet from blue, green and grey. This indicates that the fish could discriminate red or violet from other colours with almost equal ease, although they had difficulty in discriminating red from violet.

The data-sets B and I in Table I were statistically analysed by the analysis of variance technique to see whether there was any variation in response on different days and in different fishes. The analysis showed no variation, but revealed some kind of systematic error in case of the 5th day observations of the data-set I. Statistical analysis was carried out for both the original data and the data obtained by applying the $\sin^{-1}\sqrt{P}$ transformations. The results are very similar whether the transformation is applied or not.

The two data-sets B and I were also compared in order to see whether there was any colour preference which might have given rise to significant difference between the overall means in the two data-sets. The statistic is

$$t = \frac{\hat{c}_1 - \hat{c}_2}{\{\,[s.e.\ \text{of}\ \hat{c}_1]^2 + [s.e.\ \text{of}\ \hat{c}_2]^2\,\}^{\frac{1}{2}}}$$

where $\hat{c}_1$ = general means of data-set B,

$\hat{c}_2$ = general means of data-set I

and the degree of freedom for t is the sum of the error df's of the two experiments. The results are given in Table II, which shows significance of observed t at 0.1% level in any case. The table also shows that $\hat{c}_1 > \hat{c}_2$ in any case. Hence it can be concluded that preference for red colour is greater than that for blue.

TABLE II

RESULTS OF 't' TEST OBTAINED FROM OVERALL MEANS OF DATA-SETS B AND I

Item	Original Data		Transformed Data (Degree)	
	Including 5th day observations of data-set I	Excluding 5th day observations of data-set I	Including 5th day observations of data-set I	Excluding 5th day obervations of data-set I
(1)	(2)	(3)	(4)	(5)
$\hat{c}_1$	18·964	18·964	79·639	79·631
$\hat{c}_2$	17·000	17·625	69·316	71·777
s.e.$\hat{c}_1$	0·1873	0·1873	1·5763	1·5763
s.e.$\hat{c}_2$	0·1841	0·2149	1·1173	1·3093
t	7·47	4·69	5·34	3·83
df	36	33	36	33
Theoretical value of 't' at 0.1% level	3·59	3·62	3·59	3·62

DISCUSSION

In our investigation the fish *Anabas testudineus* discriminated between hues on their qualitative basis and not on their quantitative basis. This is confirmed by the use of wide range of coloured papers. It is quite unlikely the fish would be able to remember all the ten shades of a colour used as a positive stimulus. Moreover, brightness-discrimination in fish has been found to be extremely poor as is evident from the work of Reeves (1919). Reeves showed that *Semotilus* could not discriminate intensities differing in 1 : 4 ratio. This ratio for *Lepomis* is 1 : 2.

Since the fish could recognize red, green and blue, and also discriminated them from each other their vision appears to be trichromatic. Trichromasy has also been shown in *Phoxinus laevis* (Hamburger 1926) and also in goldfish (Marks 1963, Muntz & Cronly-Dilton 1966).

The fish *Anabas* showed very poor discrimination between red and violet although the colours are widest apart in the wave-length scale of the visible spectrum. Reports are there that *Phoxinus* could not discriminate red from yellow and purple, and the colour circle is closed for this fish (Frisch 1925, Wolfe 1925 and Hamburger 1926). But *A. testudineus* could recognize violet as a distinct hue and discriminated it from blue, green and grey without any difficulty. This shows that the visible spectrum is not narrowed towards the short wave end in *Anabas*. That violet and even ultraviolet at 313-253 mμ are visible to sticklebacks was reported by Merker (1934). But he suspected conversion of ultraviolet into visible light through the fluorescence of water.

Preference for red as compared to blue in these fishes might have resulted from long association of the fish with red as the positive stimulus. But the learning curve for blue in Fig. 2 did not show any significant rise with days after the 7th day. A probable explanation for this behaviour of fish is that since water and ocular media absorb and disperse most of the light of shorter wave-lengths it is quite likely that light of longer wave-lengths may reach retina in greater quantities and consequently stimulate the photoreceptors to a greater extent.

ACKNOWLEDGEMENTS

The statistical analysis was carried out with the help of Dr. N. Bhattacharyya, M. Dey, B. Mahalanobis and T. Moitra of Economics Research Unit, Indian Statistical Institute, Calcutta. The authors are thankful to Dr. H. L. Sarkar, Head of the Dept. of Zoology, Visva-Bharati University for providing laboratory facilities.

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Observations on the Vegetation of the Upper Damodar Catchment Area

BY

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This paper gives an account on the floristic composition of the vegetation of the Upper Damodar Catchment Area as observed by the author during a botanical exploration tour. It also provides a list of plants collected with up-todate nomenclature.

INTRODUCTION

A preliminary survey was made of the flora of the Upper Damodar Catchment Area during 1951 on behalf of the Damodar Valley Corporation, primarily with a view to select some of the native species for the afforestation programme of the Damodar Valley Corporation. Collections were made from several districts of South Bihar, particularly the whole of Hazaribagh and Manbhum districts.

The altitude ranges from 240 m to 660 m above sea level, and these areas are composed of plateaus and hills, with numerous ravines. Apart from the river Damodar which rises somewhere in Palamau district, and flows over a length 144 km in an eastward direction through Hazaribagh district, other important rivers of this area are Garhi, Haharo, Naikari, Maramarha, Bhera, Konar, Janjo, Jamunia and Barakar which are tributaries of Damodar and Jhikia, Chako, Dhadhar, Tilaya, Sakri, Ajoy and Subarnarekha.

The average annual rainfall is roughly between 112·5 mm and 125 mm with 80% of the total annual rainfall confined to monsoon months of June-September. The hottest months are May and June and coldest months are December and January.

Apart from the scanty literature (Hook. f. in *Journ. Asiat. Soc. Beng.* 17 : 356-411, 1848 ; Anderson ibid. 32 : 189-218. 1863 ; Wood in *Rec. Bot. Surv. Ind.* 2 : 1-170, 1903 ; Thomson in Dist. Gazett. Hazaribagh (1917) dealing with the plants of the area, there is no recent published account on the flora of the region. Therefore, the results of the explorative tour are presented in the paper.

THE FLORA

In general the vegetation of the area can be classified under monsoon or dry deciduous forest with sal as a dominant tree. The primary forest is for the greater part either degraded into scrubjungle and savannah or converted into cultivable land. The original forest is confined to ravines, hill-slopes and Reserves of Religera, Serenghatu and Morha Hill. The characteristic trees are *Anogeissus latifolia, Buchanania latifolia, Dalbergia latifolia, Terminalia tomentosa, T. chebula, T. bellerica, Cleistanthus collinus, Boswellia serrata, Pterocarpus marsupium, Antidesma ghaesembilla, Ougeinia oogeinensis, Semecarpus anacardium, Gmelina arborea, Wendlandia tinctoria, Litsea roxburghii, Croton oblongifolius* and *Dolichandrone stipulata* apart from *Shorea robusta.* The shrubby layer is composed of *Holarrhena antidysenterica, Buddleja asiatica, Canthium parvifolium, Woodfordia fruticosa, Helicteres isora, Grewia hirsuta, Desmodium pulchellum, Indigofera cassioides, Moghania paniculata, Ixora undulata, Pavetta crassicaulis, Mallotus philippensis* and *Petalidium barlerioides. Combretum roxburghii, Ventilago denticulata, Smilax zeylanica, Millettia auriculata, Abrus precatorius, Phanera vahlii* and *Ichnocarpus frutescens* are some of the commonest shrubby climbers. The herbaceous growth was poor at the time the trip was made during post-monsoon season, and is represented by perennial summer herbs like *Hemigraphis latebrosa, Lepidagathis incurva, Leucas mollissima, Nepeta hindostana, Vernonia teres, V. roxburghii, Crotalaria prostrata* and *C. albida.* The commonest herbaceous climber is *Dioscorea bulbifera.*

The vegetation of partially degraded forest and scrub jungle is composed of small often stunted trees like *Schleichera oleosa, Lannea coromandelica, Syzygium cumini, Casearia elliptica, Cochlospermum religiosum, Kydia calycina, Aegle marmelos, Butea monosperma, Erythrina variegata, Piliostigma malabaricum, Lagerstroemia parviflora, Cassia fistula, Madhuca indica, Diospyros malabarica, Mallotus philippensis, Phyllanthus emblica* and *Nyctanthes arbor-tristis.* Some of the commonest shrubs are *Xeromphis spinosa, X. uliginosa, Gardenia latifolia, Canthium parviflorum, Flacourtia indica, Azanza lampas, Maytenus bailadillana, Zizyphus mauritiana, Z. xylopyra, Desmodium pulchellum, Indigofera cassioides, Phanera retusa, Acacia farnesiana, Mimosa rubicaulis, Woodfordia fruticosa, Carissa spinarum, Eranthemum purpurascens, Perilepta auriculata, Lantana camara, Colebrookea oppositifolia, Pogostemon benghalense* and *Antidesma diandrum.* Shrubby climbers are represented by *Cryptolepis buchanani, Ichnocarpus frutescens, Combretum roxburghii, Ventilago denticulata* and *Porana paniculata.* The herbaceous growth is more or less similar to the ground flora of the original forest but with several grasses like *Capillipedeum assimile, Cymbopogon schoenanthus, C. jwarancusa, Heteropogon contortus* and *Thysanolaena maxima.* One of the peculiar features of this habitat is the presence of dwarf palm *Phoenix acaulis* and the occurrence of *Dendrocalamus strictus* in gregarious clumps.

Scattered over the savannah and near habitational sites are trees like *Shorea robusta*, *Bombax ceiba*, *Azadirachta indica*, *Sapindus laurifolius*, *Butea monosperma*, *Ailanthus excelsa*, *Tamarindus indicus*, *Madhuca indica*, *Diospyros malabarica*, *Schrebera swietenioides*, *Cassia fistula*, *Holoptelea integrifolia*, *Ficus benghalensis*, *F. racemosa* and *F. religiosa* and shrubs like *Zizyphus mauritiana*, *Carissa spinarum*, *Calotropis gigantea* and *Flacourtia indica*. The herbaceous flora is represented by *Hybanthus enneaspermus*, *Portulaca quadrifida*, *Malvastrum coromandelianum*, *Alysicarpus monilifer*, *Desmodium gangeticum*, *D. triflorum*, *Borreria articularis*, *Hedyotis hispida*, *Ageratum conyzoides*, *Blumea lacera*, *Glossogyne bidens*, *Launaea fallax*, *Tridax procumbens*, *Vernonia cinerea*, *Evolvulus alsinoides*, *Anisomeles indica*, *Boerhaavia diffusa*, *Euphorbia hirta*, *E. thymifolia*, *Cyperus rotundus*, *Bothriochloa intermedia*, *Cynodon dactylon*, *Eragrostis tenella* and *Imperata cylindrica*.

Tamarix ericoides and *Bombax ceiba* are common along river beds, while *Salix tetrasperma* and *Homonia riparia*, constitute rheophytic vegetation. Exotic weeds like *Lantana camara* and *Argemone mexicana* often form gregarious clumps on stabilised riverine islands. *Phyla nodiflora*, *Eragrostis coarctata* and *Polygonum plebejum* are the commonest herbs of sandy river beds.

Hydrophytic vegetation of stagnant waters, ditches and ponds is represented by species like *Najas marina*, *Lemna perpusilla*, *Potamogeton indicus* and *P. nodosus*. *Hygrophila auriculata*, *H. polysperma*, *Bacopa monnieri*, *Limnophila rugosa*, *Panicum repens* and *Phragmites karka* constitute the vegetation of the marshy and swampy localities. The margins of these watery localities are inhabited by *Polygonum glabrum*, *Cyathocline purpurea* and *Cyperus* sp.

Epiphytes are represented by *Rhynchostylis retusa* and *Vanda parviflora*.

Cuscuta reflexa is a sole representative of total stem-parasites, while *Dendrophthoe falcata* and *Viscum nepalense* represent partial stem-parasites.

Some of the exotic weeds that are established and naturalized in this area are *Argemone mexicana*, *Crotalaria mucronata*, *Malvastrum coromandelianum*, *Ageratum conyzoides*, *Tridax procumbens*, *Solanum torvum* and *Lantana camara*.

Azadirachta indica, *Tamarindus indica*, *Mangifera indica*, *Millingtonia hortensis*, *Cassia siamea*, *Albizzia lebbek*, *Grevillea robusta*, *Pongamia pinnata*, *Eucalyptus* sp., *Tectona grandis* and *Pterospermum acerifolium* are some of the common road-side trees.

Agricultural crops of the area are *Triticum aestivum*, *Cajanus cajan*, *Pennisetum typhoides*, *Cicer arietinum*, *Linum usitatissimum*, *Carthamus tinctorius*, *Oryza sativa*, *Zea mays* and *Pisum sativum*.

LIST OF SPECIES

SELAGINELLACEAE

Selaginella flaccida Spring.

EQUISETACEAE

Equisetum debile Roxb.

SCHIZAEACEAE

Lygodium flexuosum (Linn.) Sw.

PTERIDACEAE

Adiantum philippense Linn.
Aleuritopteris farinosa (Forsk.) Fee
Pteris vittata Linn.

ASPLENIACEAE

Diplazium esculentum (Linn.) Sw.

POLYPODIACEAE

Polypodium proliferum Roxb.

ANGIOSPERMS

PAPAVERACEAE

Argemone mexicana Linn.

VIOLACEAE

Hybanthus enneaspermus (Linn.) F. V. Muell

COCHLOSPERMACEAE

Cochlospermum religiosum (Linn.) Alst.

FLACOURTIACEAE

Casearia elliptica Willd.
Flacourtia indica (Burm. f.) Merr.

PORTULACACEAE

Portulaca oleracea Linn.
P. quadrifida Linn.

TAMARICACEAE

Tamarix ericoides Rottl.

DIPTEROCARPACEAE

Shorea robusta Gaertn.

MALVACEAE

Azanza lampas (Cav.) Alef.
Kydia calycina Roxb.
Malvastrum coromandelianum (Linn.) Garcke

Urena lobata Linn.

BOMBACACEAE

Bombax ceiba Linn.

STERCULIACEAE

Eriolaena hookeriana Wt. & Arn.
Helicteres isora Linn.

TILIACEAE

Grewia hirsuta Vahl

MALPIGHIACEAE

Hiptage benghalensis (Linn.) Kurz

RUTACEAE

Aegle marmelos (Linn.) Corr.

SIMAROUBACEAE

Ailanthus excelsa Roxb.

BURSERACEAE

Boswellia serrata Roxb.
Bursera serrata Colebr.

MELIACEAE

Azadirachta indica A. Juss.
Soymida febrifuga A. Juss.
Toona ciliata Roem.

OLACACEAE

Olax scandens Roxb.

CELASTRACEAE

Maytenus bailadillana (Narayan & Mooney) Raju & Babu
Celastrus paniculata Willd.

RHAMNACEAE

Ventilago denticulata Willd.
Zizyphus mauritiana Lamk.
Z. xylopyra Willd.
Z. oenoplia Mill.

VITACEAE

Ampelocissus latifolia (Roxb.) Planch.

SAPINDACEAE

Cardiospermum halicacabum Linn.
Sapindus laurifolius Vahl
Schleichera oleosa (Lour.) Oken

ANACARDIACEAE

Buchanania latifolia Roxb.
Lannea coromandelica (Houtt.) Merr.
Semecarpus anacardium Linn. f.

FABACEAE

Abrus precatorius Linn.
Alysicarpus monilifer DC.
A. vaginalis (Linn.) DC.
Butea monosperma (Lamk.) Taub.
B. superba Roxb.
Crotalaria albida Heyne ex Roth
C. mucronata Desv.
C. prostrata Rottb. ex Willd.
Dalbergia latifolia Roxb.
D. sissoo Roxb.
Desmodium gangeticum (Linn.) DC.
D. pulchellum Benth.
D. triflorum (Linn.) DC.
Erythrina variegata Linn.
Indigofera cassioides Rottl.
I. linifolia Retz.
Millettia auriculata Baker ex Brandis
Moghania paniculata (Wall.) Li
Ougeinia oogeinensis (Roxb.) Hochr.
Pongamia pinnata (Linn.) Pierre
Pterocarpus marsupium Roxb.
Uraria rufescens (DC.) Schindl.

CAESALPINIACEAE

Bauhinia purpurea Linn.
Cassia fistula Linn.
Phanera retusa (Buch.-Ham. ex Roxb.) Benth.
P. vahlii (Wt. & Arn.) Benth.
Piliostigma malabaricum (Roxb.) Benth.
Tamarindus indicus Linn.

MIMOSACEAE

Acacia catechu Willd.
A. farnesiana Willd.
A. polyacantha Willd.
Albizzia lebbek (Linn.) Benth.
A. odoratissima (Linn. f.) Benth.
Mimosa rubicaulis Lamk.

DROSERACEAE

Drosera burmanni Vahl

COMBRETACEAE

Anogeissus latifolia (Roxb.) Bedd.
Combretum roxburghii Spreng.
Terminalia bellerica (Gaertn.) Roxb.
T. chebula Retz.
T. tomentosa Bedd.

MYRTACEAE

Psidium guajava Linn.
Syzygium heyneanum (Duthie) Gamble
S. cumini (Linn.) Skeels

BARRINGTONIACEAE

Careya arborea Roxb.

LYTHRACEAE

Lagerstroemia parviflora Roxb.
Woodfordia fruticosa (Linn.) Kurz

APIACEAE

Centella asiatica (Linn.) Urban

ALANGIACEAE

Alangium salvifolium (Linn.f.) Wangerin

RUBIACEAE

Adina cordifolia (Roxb.) Hook.f. ex Brandis
Borreria articularis (Linn.f.) F. N. Willd.
Canthium parvifolium Roxb.
Gardenia latifolia Ait.
Hedyotis hispida Retz.
Ixora undulata Roxb.
Pavetta crassicaulis Bremek.
Wendlandia heynei (R. & S.) Sant. & Merch.
W. tinctoria (Roxb.) DC.
Xeromphis spinosa (Thunb.) Keay
X. uliginosa (Retz.) Mahesh.

ASTERACEAE

Ageratum conyzoides Linn.
Blumea fistulosa (Roxb.) Kurz
B. lacera DC.
Cyathocline purpurea (D. Don) O.K.
Glossogyne bidens (Retz.) Alston
Launaea acaulis (Roxb.) Babcock ex Craib
L. fallax (Jaub. & Spach.) O.K.
Sphaeranthus indicus Linn.
Tridax procumbens Linn.
Vernonia cinerea (Linn.) Less.
V. roxburghii Less.
V. teres Wall. ex DC.

MYRSINACEAE

Embelia tsjeriam-cottam DC.

SAPOTACEAE

Madhuca indica Gmel.

EBENACEAE

Diospyros malabarica (Desr.) Kostel.

SYMPLOCACEAE

Symplocos racemosa Roxb.

OLEACEAE

Jasminum arborescens Roxb.
Nyctanthes arbor-tristis Linn.
Schrebera swietenioides Roxb.

APOCYNACEAE

Carissa spinarum Linn.
Holarrhena antidysenterica (Roth) DC.
Ichnocarpus frutescens (Linn.) R.Br.

ASCLEPIADACEAE

Calotropis gigantea (Willd.) Dryand. ex Ait.f.
Cryptolepis buchanani R. & S.
Hemidesmus indicus Schult.

LOGANIACEAE

Buddleja asiatica Lour.
Cynoctonum mitreola (Linn.) Britt.

GENTIANACEAE

Canscora diffusa (Vahl) R. Br. ex Wall.
Exacum pedunculatum Linn.
Hopea dichotoma Willd.

BORAGINACEAE

Cordia dichotoma Forst.f.
Trichodesma indicum R.Br.

CONVOLVULACEAE

Cuscuta reflexa Roxb.
Evolvulus alsinoides (Linn.) Linn.
E. nummularius (Linn.) Linn.
Merremia quinata (R.Br.) Ooststr.

Operculina petaloidea (Choisy) Ooststr.
Porana paniculata Roxb.
Rivea hypocrateriformis Choisy

SOLANACEAE

Solanum indicum Linn.
S. torvum Sw.

SCROPHULARIACEAE

Bacopa monnieri (Linn.) Penn.
Limnophila rugosa (Roth) Merr.

BIGNONIACEAE

Dolichandrone stipulata (Roth) Benth.

ACANTHACEAE

Andrographis paniculata (Burm.f.) Nees
Barleria cristata Linn.
B. strigosa Willd.
Eranthemum purpurascens Nees
Hygrophila auriculata (Schum.) Heine
H. polysperma (Roxb.) T. And.
Hemigraphis latebrosa Nees
Justicia betonica Linn.
Lepidagathis incurva D.Don
Perilepta auriculata (Nees) Brem.
Petalidium barlerioides (Roth) Nees
Rungia parviflora Nees

VERBENACEAE

Clerodendrum viscosum Vent.
Gmelina arborea Roxb.
Lantana camara Linn.
Phyla nodiflora (Linn.) Green
Tectona grandis Linn.f.
Vitex negundo Linn.

LAMIACEAE

Anisomeles indica (Linn.) O.K.
Colebrookea oppositifolia Sm.
Leucas mollissima Wall.
L. linifolia Spreng.
Nepeta hindostana (Roth) Haines
Ocimum basilicum Linn.
O. gratissimum Linn.
Pogostemon benghalense (Burm. f. O.K.
P. purpurascens Dalz.

NYCTAGINACEAE

Boerhaavia diffusa Linn.

POLYGONACEAE

Polygonum glabrum Willd.
P. plebejum R. Br.

ARISTOLOCHIACEAE

Aristolochia indica Linn.

LAURACEAE

Litsea monopetala (Roxb.) Pers.
L. roxburghii (Nees) Hassk. ex Back.

LORANTHACEAE

Dendrophthoe falcata (Linn.f.) Etting.
Viscum nepalense Spreng.

EUPHORBIACEAE

Antidesma diandrum (Roxb.) Roth
A. ghaesembilla Gaertn.
Breynia rhamnoides (Retz.) Muell.-Arg.
Cleistanthus collinus (Roxb.) Benth.
Croton oblongifolius Roxb.
Euphorbia hirta Linn.
E. thymifolia Linn.
Jatropha curcas Linn.
Homonoia riparia Lour.
Mallotus philippensis (Lamk.) Muell.-Arg.
Phyllanthus emblica Linn.
P. reticulatus Poir.
Sebastiania chamaelea (Linn.) Muell.-Arg.

ULMACEAE

Holoptelea integrifolia (Roxb.) Planch.

MORACEAE

Ficus benghalensis Linn.
F. racemosa Linn.
F. religiosa Linn.
F. virens Ait.

SALICACEAE

Salix tetrasperma Roxb.

ORCHIDACEAE

Rhynchostylis retusa Bl.
Vanda parviflora Lindl.

AMARYLLIDACEAE

Crinum asiaticum Linn.

AGAVEACEAE

Agave vera-cruz Mill.

DIOSCOREACEAE

Dioscorea bulbifera Linn.

LILIACEAE

Asparagus racemosus Willd.
Gloriosa superba Linn.

COMMELINACEAE

Commelina benghalensis Linn.
C. hasskarlii Cl.

ARECACEAE

Borassus flabellifer Linn.
Phoenix acaulis Buch.-Ham. ex Roxb.

LEMNACEAE

Lemna perpusilla Torrey

NAJADACEAE

Najas marina Linn.

POTAMOGETONACEAE

Potamogeton indicus Roxb.
P. nodosus Poir.

CYPERACEAE

Cyperus rotundus Linn.
Fimbristylis bisumbellata (Forsk.) Bulb.
F. cymosa R.Br.

POACEAE

Arundo donax Linn.
Bothriochloa intermedia (R.Br.) A. Camus
Capillipedeum assimile (Steud.) A. Camus
Chrysopogon aciculatus (Retz.) Trin.
Cymbopogon jwarancusa (Jones) Schult.
C. schoenanthus (Linn.) Spreng.
Cynodon dactylon (Linn.) Pers.
Dendrocalamus strictus Nees
Dichanthium annulatum (Forsk.) Stapf
Digitaria adscendens (H.B.K.) Henr.
Eragrostis coarctata Stapf ex Hook. f.
E. tenella (Linn.) P. Beauv. ex R. & S.
Heteropogon contortus (Linn.) P. Beauv. ex R. & S.
Imperata cylindrica (Linn.) P. Beauv.
Panicum repens Linn.
Phragmites karka (Retz.) Trin.

Rottboellia exaltata Linn.f.
Sporobolus diandra (Retz.) P. Beauv.
Thysanolaena maxima (Roxb.) O.K.
Vetiveria zizanioides (Linn.) Nash.

Acknowledgement

The author wishes to express his appreciation to Dr. S. K. Mukherjee, Keeper, Central National Herbarium for his kind help in the identification of some of the plants.

An ecological Survey of the larger Mammals of Peninsular India

BY

M. KRISHNAN

(*With ten plates*)

[*Continued from Vol.* **68** (3) : 555]

THE TIGER

Panthera tigris (Linnaeus)

(Summary of field notes : Observation records : 22, of which 18 were in the Kanha National Park, M.P., in May 1968, limited to 4 animals. Fresh pugs : 16. Other conclusive evidence of presence : 2.

Locations : Tamil Nadu—Mudumalai Sa. : Andhra Pradesh—Kawal Sa. ; Orissa—Balimela, Purnakote : Bihar—Hazaribagh N.P., Palamau N.P., the bed of the river Koel : Madhya Pradesh—Kanha N.P., Bara Naya Para : Uttar Pradesh—Corbett N.P.

Photographs : MP 4, MP 7, MP 9, MP 10, MP 11, MP 12 : B 11)

MORE has been written about the tiger than any other Indian animal but most of it has been about how to shoot it or, more often, how the author shot it ; there are even entirely anthropomorphic 'autobiographies' of it ! Some of the habits and reactions of the tiger have been observed and reported by hunters such as Jim Corbett, and a closer study of it made by Dunbar Brander : some of this information has been taken into account in Prater's book, and a scientific and meticulously observed account of the tigers in the Kanha N. P., Madhya Pradesh, is furnished in Schaller's THE DEER AND THE TIGER. A great deal of information is available on the tiger in all this literature.

Size : Morphological characters

Adult size differs with individuals, but as a rule the male is considerably larger than the female. Dunbar Brander provides a factual and informed discussion of the size and weight attained by tigers. The ground colour varies from the off-white of the albinotic 'white' tigers of Rewa through ochre to burnt sienna, and the shoulders and head may be lighter than the body in ground colour ; the abdomen, chest, chin, and insides of the limbs are also white in ground colour, as also a ' sun-spot ' above the eye, and the ruff above the cheeks. The stripes are variable in number, colour and formation, even in adults from the same litter, and further the ground colour and stripe spacing varies somewhat with age ; the stripes are solid and broad on the abdomen and the insides of the limbs (where the ground colour is white). The patch of white above each eye is marked with a varying pattern of black, but there is always a thin rim of white to the eyes ; the black spots on either side of the lips, from which the moustachial vibrissae arise, coalesce into thin bars, and high up the chin (near the mouth) there are some small black spots. The hair on the inside of the ears is white, and on the dorsal aspect of each ear the colouring is black with a large, prominent, almost white spot in the centre.

Many observers have commented on the obliterative or cryptic pattern of the tiger's coat, which is said to blend perfectly with the streaky appearance of tall grass and small bushes. It is obvious that to have any significance in its life, such colouring must have one or both of two functions : it may be protective and help in not betraying the tiger to its enemies, or it may be assimilative and help in not betraying the tiger to its prey. Apart from men, the tiger's chief adversaries consist mainly of other tigers, and ticks and similar parasites, so that the first aspect of the matter need not be considered further. In considering the value of the tiger's seemingly assimilative colouring to its hunting, it should be remembered that the perceptions of the prey species are not dominated by colour-sensitive vision, as ours are, and are more versatile, that so far as is known their vision is monochromatic and that the tiger hunts at night. Although it is often abroad and occasionally hunts by day, its hunting is done mainly at night. After sunset, a different kind of optic perspicacity governs even our colour-sensitive vision, for colour is no longer appreciable ; the ability to see clearly by low light levels, and to sense slight movements rather than static form becomes important. Further, like other cats, the tiger creeps upon its prey till near enough to attack in a rush, crouching low and taking advantage of every bit of cover, depending more on not being seen at all than on assimilative coloration—some observers, going by the lack of stealth of tigers at times in attacking tethered live baits, have overlooked the entirely artificial circumstances then obtaining.

The colouring of the tiger's coat is only a specific variation of a generic pattern, and it is in the leopard that such specific variation attains its most remarkable obliterative efficiency.

Distribution

Within peninsular India, the tiger has long been known wherever there were tree forests, and an adequate source of water (which could be quite small). Its present status (when in many of its former haunts it is now rare or locally extinct, and when in others its natural prey has been so depleted by hunting and trapping that its survival is endangered because in such localities it now constitutes a threat to cattle and men) strikingly illustrates the unpredictable consequences of interfering with the balance of nature, and also the fallacy of the theory that a little thinning of numbers for shikar will not affect a fast-breeding animal like the tiger. Within the past two decades, the tiger has declined so substantially, and even dramatically, in peninsular India that no reliable estimate of its numbers can be made, in view of the lack of dependable statistics, and it is difficult to make any firm statement on its present distribution in the peninsula, but it still seems to be there, in many of its former haunts, though conditions in those areas have changed considerably and may speed its further decline.

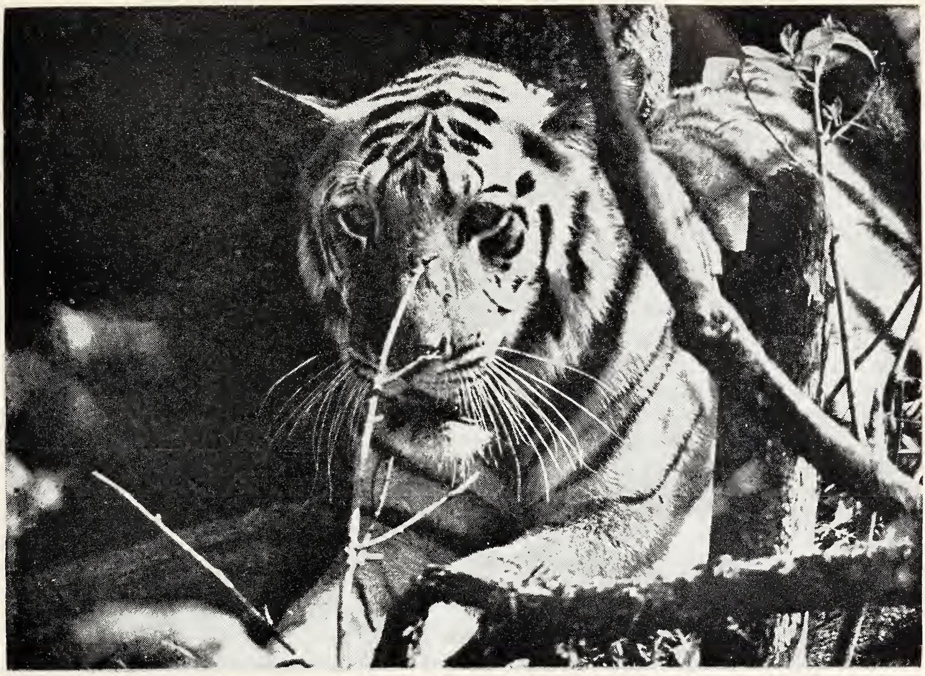
Habits : Behaviour

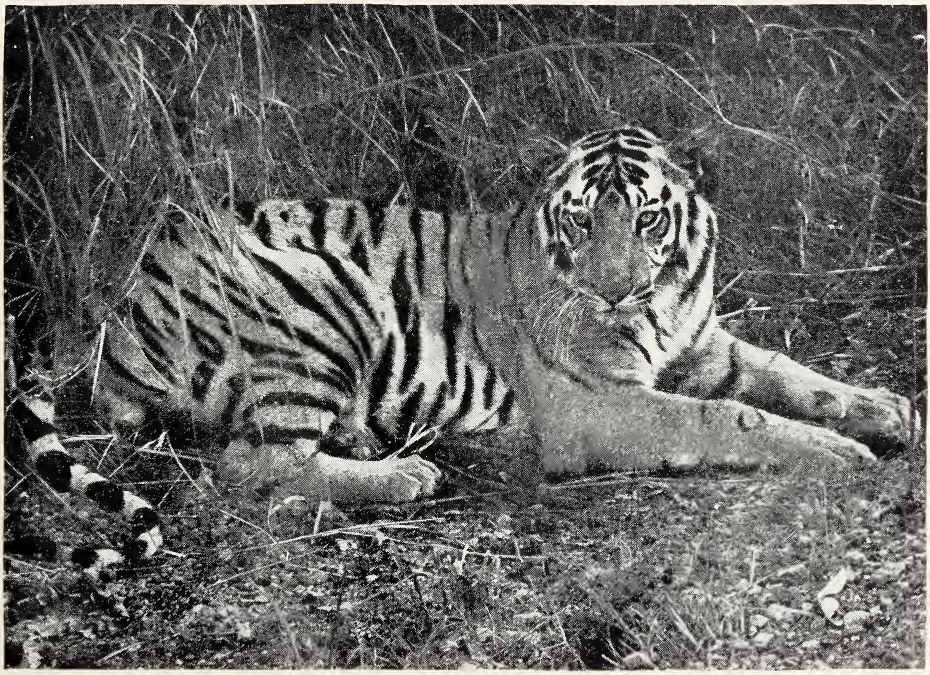
In the Kanha N.P., in the first 12 days of May 1968, 4 tigers (2 adult tigresses and 2 male subadults about a year old) were seen by day on 18 different occasions. The 2 male subadults were the cubs of the younger and smaller tigress, and one of them was considerably bulkier than the other, almost as big as his mother ; the older, richer-coloured and much larger tigress seen once was said to be the mother of the young tigress (MP 68 May 1, 3, 4, 5, 6, 7, 9, 11 p.m.—photographs MP 4, MP 7, MP 11).

Apparently this was a family party, living under somewhat artificial conditions, with the younger tigress and the 2 subadults tied to the area by the regular provision of buffalo baits over a long period. In these circumstances it is hardly worth the while drawing conclusions, from observation of them, on the daily activity cycle of tigers, hunting and feeding, reactions to men and similar behaviour, but in other matters, such as intraspecific communications, avoidance of heat and glare, and instinctive responses they were no doubt entirely natural. Further, the conditions under which this family party of three was induced to stay more or less within two square miles of the Kanha meadow, and the repercussions of the sustained provision of inducements, are interesting.

The tigers were active in the mornings till about 8 a.m. after feeding on the bait killed at night ; then they lay up in the undershrub of a wooded nullah or in tall grass. Everyday they were disturbed in such cover by visitors to the sanctuary on elephant back till about 11 a.m., but only retreated deeper into the cover or shifted higher up the wooded hillock besides the nullah, though resentment of such disturbance was evinced even by the subadult tigers. Apparently they slept or rested in shade till evening, when they were again on the move. Usually they

Krishnan : Mammals

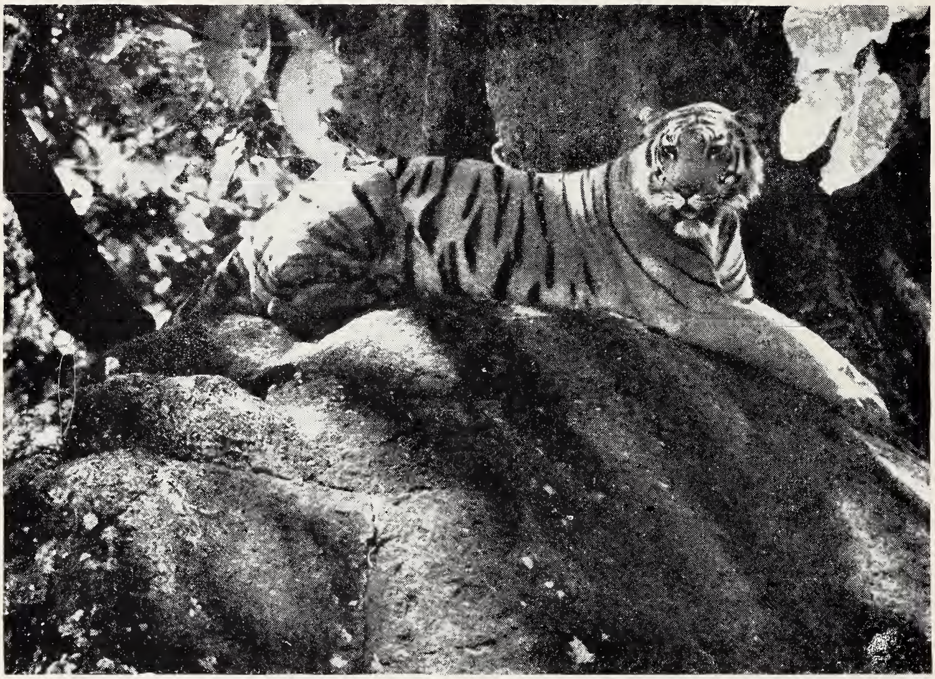


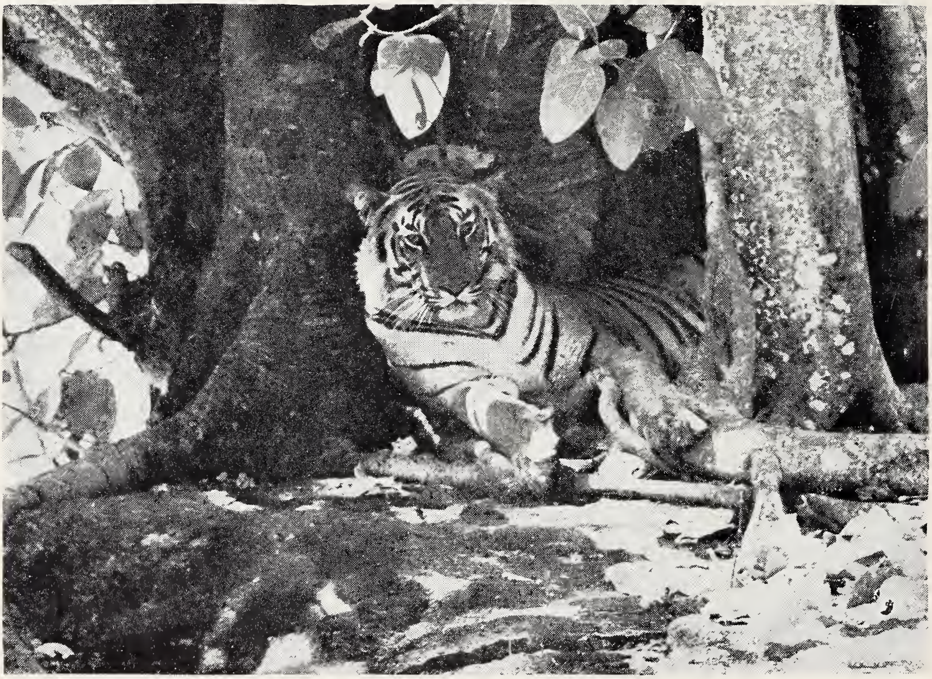


Above : M. P. 1968 : KANHA N. P. : May 4 — a.m. : The larger of the two subadult tigers — MP. 4 ; *Below :* M. P. 1968 : KANHA N. P. : May 6 — a.m. : Portrait of the larger subadult tiger — MP. 7.

(*Photos : M. Krishnan*)

Krishnan : Mammals





Above : M. P. 1968 : KANHA N. P. : May 8 — a.m. : The tigress on the rock — MP. 9 ;
Below : M. P. 1968 : KANHA N. P. : May 11 — a.m. : The tigress in the corridor between the bole of the banyan and a pillar root — MP. 10.

(*Photos : M. Krishnan*)

did not stay together, the 2 young tigers staying near each other, or one in the nullah and the other in the wooded hillock, and the tigress choosing different retreats not too far away. The heat and glare were fierce, and once the tigress was located deep inside a cool, dark cave ; twice she was seen cooling herself in rock-girt pools (MP 68 May 10 & 12 : photograph MP 12).

In May 1968, only this group of 3 (the smaller tigress and her 2 yearling cubs) were killing the baits provided, and had been accustomed to do so over a period of months. Evidently what had originally attracted the tigress to the area was the need to provide for growing cubs coupled with the assured availability of easy, staked-out prey. It was said that the larger tigress (the reputed mother of the smaller) had visited the kills once or twice. There was another tiger in the forests beyond the Kanha meadow, a large male, but he did not come to the kill.

Once I found the smaller tigress lying up in a tussock of tall grass, and at our approach (on elephant back) she entered an extensive patch of tall grass across a forest road and proceeded, hidden by the cover, to where the larger tigress was lying up, about 100 yards away. Approaching the larger tigress, she came out with repeated low, vibrant, whining calls, reminiscent of the call used by a chained-up hound wishing to attract the attention of a man—these, evidently, were placatory, and the two tigresses were on amicable terms (MP 68 May 11 : photograph MP 11).

Although accustomed over months to being photographed and watched at night from the elevated, covered hide, while feeding with her cubs on the kill, and to being followed by visitors to the park on elephant back in the mornings, this group of tigers had not developed that indifference to human proximity that lions in similar circumstances develop, but were tense and resentful.

Schaller, analysing the reports of others and his own observation of the social interactions of adult tigers, says these are best understood in the three separate contexts of hunting, mating and feeding : he concludes that usually tigers hunt alone, that rival males attracted to a receptive female are antagonistic to one another, and that they ' appear to socialize more at kills than any other occasion '. He cites 3 detailed personal observation records in support of this, and it is noteworthy that in all of them the kill was by one particular tigress with 4 cubs, that the prey killed was domestic cattle, and that the tiger, and the 2 other tigresses, that were allowed to feed on these kills were, presumably, previously known to the tigress with 4 cubs. He further records that while the behaviour of this tigress was friendly towards the tiger, her acceptance of the other 2 tigresses at the kill was hostile ; it is interesting to note that superior size did not determine commensal priority, but that the ' owner ' of the kill seemed to have precedence.

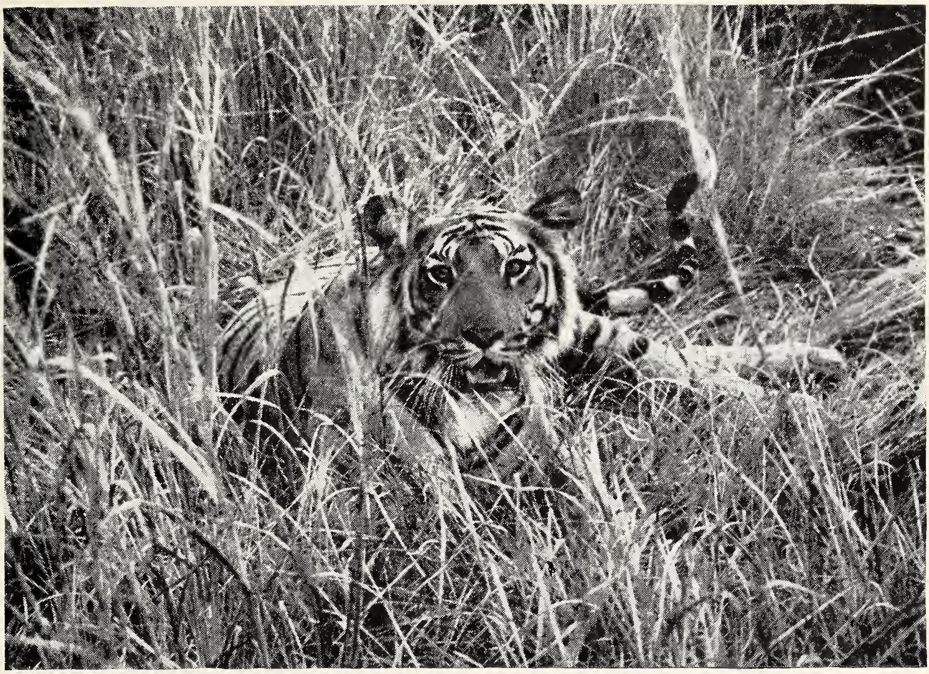
There are many other instances, recorded by earlier observers, of 2 or more tigers feeding at the same kill, but as far as can be ascertained those tigers had previously accepted one another, and in many instances were closely associated.

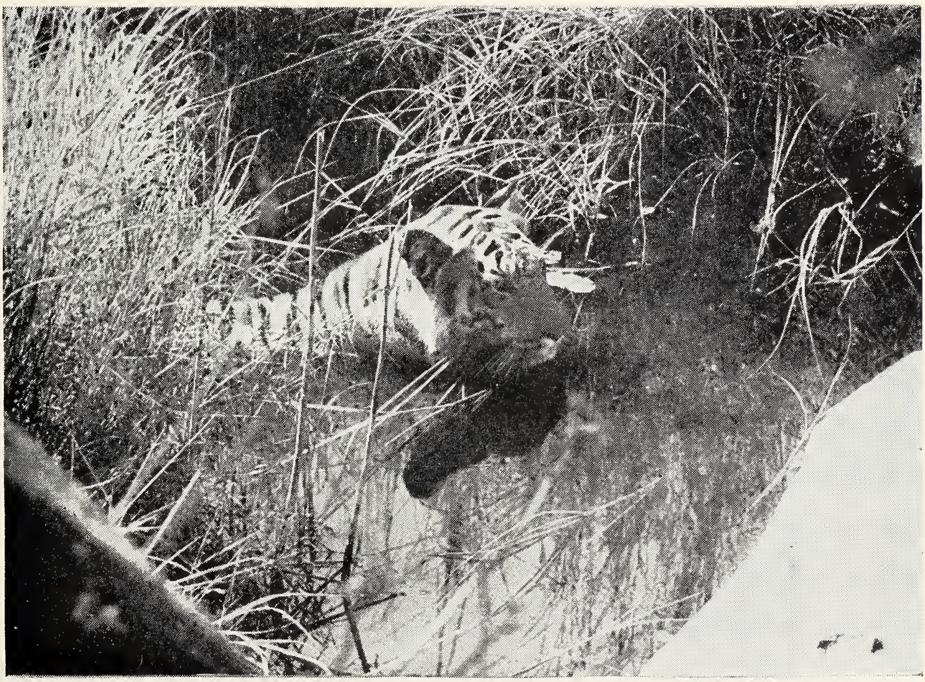
Undoubtedly the findings of Schaller, Dunbar Brander and others, with regard to the sociability of tigers at kills, are entirely valid, but such records of commensal amiability, or unwilling mutual tolerance, do not exhaust the scope of this particular context, nor are the three contexts mentioned above the only main contexts of adult intraspecific interactions among tigers. There are records of tigers having appropriated the kills of others, and such appropriations were not, obviously, amiably permitted. Further, in commenting on the sharing of territory by tigers, Schaller points out that once social dominance is established, in further encounters fights are avoided by the mutual acceptance of dominant or submissive behaviouristic expressions. In no animal is such acceptance immutable or unconditional. Other factors may condition such armed neutrality, such as the size and food-appeal of a kill, maternal instinct, or even emotional states. Sex also has to be considered. A tigress may not fight a tiger, but may resent the intrusion of another tigress into the area.

Moreover, artificial inducements and influences sometimes lead to internecine fights. In May 1968 I made diligent inquiry of the park officials at Kanha, and learnt that a few months previously another tigress, with one cub, was known in the area, but that she had been killed in a conjoint attack by the two adult tigresses I had seen (the mother of the yearlings, and her mother), in the very nullah occupied by the family party of three that I was observing. There was no reason for doubting the truth of this statement. I heard it from 4 different sources, two of them had actually seen the carcass of the dead tigress and the footprints and blood marks at the scene of the killing. Nothing was known of the fate of the cub with this tigress. Later in the same month, at the Corbett N.P. of Uttar Pradesh, where also baits were regularly tied out to attract tigers to the Dhikala area so as to display them to visitors, I learnt that a tiger had been killed in an intraspecific fight. In March 1969 no tiger was taking the baits staked out at Schaller Tower, Kanha, though I believe there were one or two kills when the baits were tied in different localities : only one set of fresh pugs were seen, of a tigress (MP 69 Mar. 10). There was a report of another tiger having been killed in an intraspecific fight since my previous visit, but no inquiry was possible. In March 1970, no tigers were taking any baits in the Kanha park : apparently no tigress with cubs had been attracted to the area.

Writing of the tiger's might eighteen centuries ago, the Tamil poet Paranar said that it was so powerful that it could kill and carry a bullock.

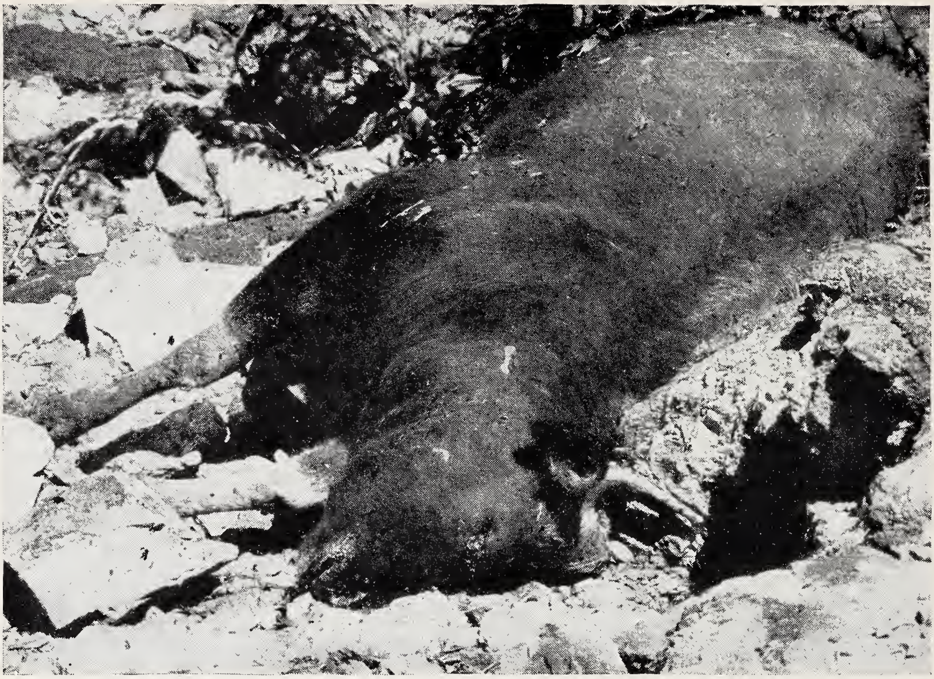
Krishnan : Mammals

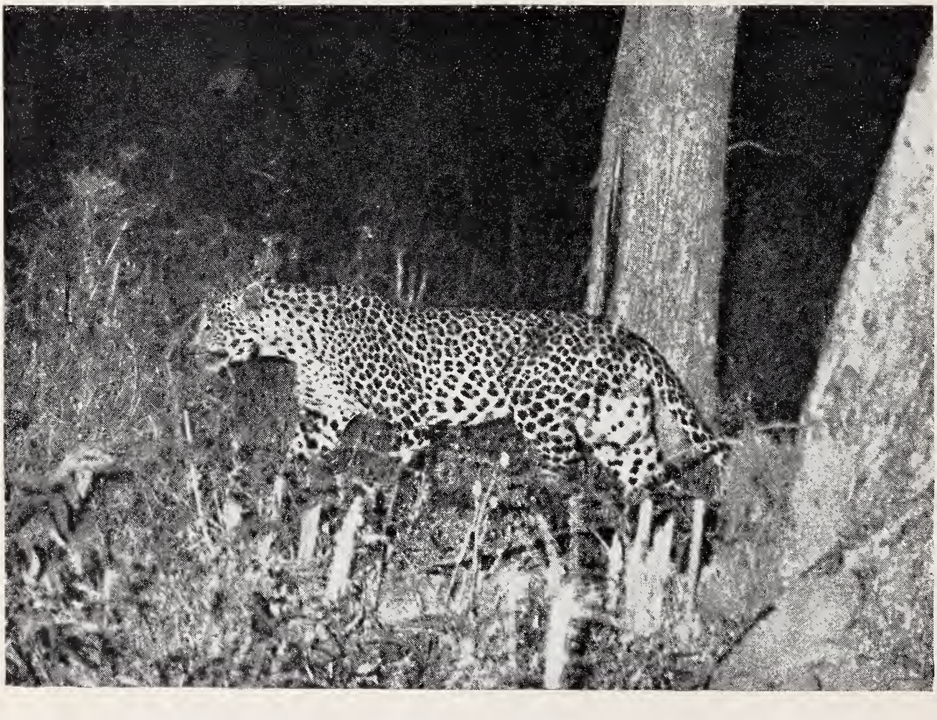




Above : M. P. 1968 : KANHA N. P. : May 11 — p.m. : 'Bade Ma' — MP. 11 ; *Below :* M. P. 1968 : KANHA N. P. : May 12 — a.m. : The tigress in a pool — MP. 12.

(*Photos : M. Krishnan*)





Above : BIHAR 1969 : BETLA : PALAMAU : February 17 — p.m. : Adult gaur cow killed by a tiger — B. 11 ; *Below* : MAHARASHTRA 1968 : TAROBA N. P. : November 25 — about 7 p.m. : A big male leopard — MR. 6.

(*Photos : M. Krishnan*)

Schaller records a tiger killing an adult bull gaur in the Kanha park, a much more impressive performance. I saw the freshly-killed carcass of an adult gaur cow in the Palamau N.P., killed single-handed by an adult male tiger well known in the area : the tracks showed where the tiger had attacked the cow, in tree forest, and later dragged the kill down a decline to the middle of a stony, open nullah where he had abandoned it, with no attempt to cover it : he did not return to the kill, which was lying close to a forest road. The remarkable feature of this kill (which was inspected by several others, besides me) was that there were no claw marks on the gaur's hide, and that the only wounds were two sets of two deep, punctured wounds, inflicted by the canines, on either side of the nape ; the throat had not been bitten (B 69 Feb. 17 : photograph B 11).

S. R. Choudhury of the Orissa Forest Department related a quite remarkable instance of a tiger's self-assurance in making a kill, to which he had been an eye-witness. He was watching a line of elephants slowly going up a forested hill along a narrow ledge, from far away, when a tiger suddenly leaped on to the ledge from bush cover, made a lightning pass at a young calf, and retreated into cover before the excited adult elephants could intervene ; the attack was said to have lasted only a few seconds. The infant collapsed and later died, and after a long while the elephants, including the mother of the calf, left the carcass and went up the hill. I saw an interesting set of fresh footprints on the bed of the Koel, showing how a tiger had followed a party of elephants (which included an infant) part of the way across the dry river bed (B 68 Apr. 23). In the Palamau N.P., at Hathbajhwa, I heard a tiger growling from the dense cover behind the watch-tower, from which a young elephant calf had emerged, and saw a number of adult elephants entering the cover, presumably to investigate (B 69 Feb. 19, 4 p.m.).

Tigers will drink from a small, muddy puddle at times, when a river or pool is available not too far away, as noticed in the Mudumalai Sa. and also in Palamau N.P. (B 68 Apr. 27). The tigress observed in Kanha in 1968 was very sleepy by about noon, after feeding on the kill at night, but evidently mistrustful of reclining on the ground when men on elephant back were close by. Thrice, she left the tall grass cover in which she had been lying up when approached, and walked towards a boulder-strewn part of the forest about two furlongs away. On the first occasion, she stopped frequently to urinate, roll on her back, and lie down once briefly on a bare patch, in what seemed displacement activity ; then she went on to a rounded rock about 9-foot high and climbing it, stretched herself on top, in the shade of a young banyan that grew there : she watched us sleepily as the riding elephant slowly approached the rock and halted 30 feet from her, then her eyes closed partially as she rested her chin on her paws, still facing us. In another minute she was sound asleep, turning her body over on one side to relax fully. On the other two occasions she went to another rock nearby, also about 9-foot high, also with a banyan tree shading it, but growing on top with pillar roots close by the trunk : she ensconced herself in the corridor between bole and pillar, stretched flat on her stomach, and watched our approach from half-closed sleep-heavy eyes : as she watched us, her eyes closed to mere slits, her raised head began to nod, and finally dropped on to her paws, and she was asleep. This was no passive form of displacement behaviour, it was sleep all right, authentic, compulsive somnolence, probably induced by heavy feeding. Seated on the elephant, I was on a level with her and was able, by slowly backing the elephant (the approach was intentionally made with the head of the elephant turned away from the rock) closer in by degrees, to get near, on one occasion getting as close as 12 feet from her nose by accurate rangefinder measurement.

She slept, so to speak, with eyes shut tight and ears wide open. Fairly rapid movements of my hands and body, the sounds made by the release and resetting of the camera's shutter and the winding on of the film, my directions to the mahout in a low tone and, later, even my whistling to make her look up, failed entirely to rouse her. I was positively anxious not to do anything that might panic her, as the impossibly contrasty lighting, with the overhead sun casting patches of dense shade and brilliant highlights all over, presented quite sufficient photographic problems without the added one of the subject bolting. However, in an attempt to get her to raise her head and open her eyes fully, loud clucks with the tongue were tried, to no effect. Everytime the elephant was moved, the noise of its feet on the litter-strewn ground made her open her eyes partially, for visual confirmation of her hearing, and I was able to get her to raise her head and stare sleepily only by making the elephant shuffle feet without moving. Her judgment of our position by ear alone was remarkable (MP 68 May 8, 10, 11 : photographs MP 9, MP 10—other photographs, showing this tigress with the head resting on her paws or on the rock, and the eyes closed or partly open, have not been printed for this report).

Besides vocalisations (of which Schaller provides a succinct account) variations in attitudes and deportment seem to play an important part in intraspecific communications, as in other cats. The staring ear-spot seems to serve as a flag only when the ears are pricked and seen from behind the tiger.

THE LEOPARD

Panthera pardus (Linnaeus)

(Summary of field notes : Observation records : 13. Fresh pugs and other conclusive evidence of presence : 7.

Locations : Tamil Nadu—Mudumalai Sa.: Orissa—Simlipal hills: Maharashtra—Taroba N.P.

Photograph : MR 6.)

Widely recognised as the most variable of the greater cats morphologically, at one time there was a distinction between a larger panther and a smaller leopard, but now it is realised that they represent only individual and ontogenetic variations of the same species. Currently, there is a revival of taxonomic interest in possible regional races, even within peninsular India. The black leopard is only a melanistic variation, generally found in the denser and more evergreen forests ; its reported smaller size seems entirely due to its much darker ' whole ' colour.

Size : Morphological characters

Adult size varies widely, from near 6-foot (between pegs) to 8 feet, but this gives a poorer indication of size than weight, as the length of the tail has no relation to body size. Weights vary from 60 to 160 lb. These variations are not regional. In personally verified records of the length (between pegs), weight, and pelage patterning of 14 leopards shot (by others) in the same area of the Deccan during the forties, the following are included :

1. Adult male, 6′ 1″ long ; weight 64 lb. The coat was short, smooth, and very richly patterned with close-set jet-black spots and rosettes on a fulvous burnt sienna ground, with the ground colour of the abdomen, chest, chin, the sides of the jaws, the inner aspects of the limbs and the distal part of the long tail conspicuously white.
2. A male in his prime, 7′ 7″ long : weight 158 lb. The abdomen was tucked in, and when cut up the stomach was empty ; when gorged this animal would have turned the scales at close on 170 lb. The coat was raw sienna in ground colour, with the chin, a small ruff, the chest, abdomen and the insides of the limbs off-white, and black spots and small rosettes.
3. An old male, heavily built and with a domed head. Mistaken for a tiger in the evening light. Length 7′ 1″, tail 32″ ; weight 132 lb. The extraordinary feature of this animal was that the chin, chest and abdomen were a light yellow ochre, even the hair inside the ears. The body colour was a deep, dull ochre and the spots and rosettes indistinct against the ground colour, being a graphite-grey rather than black. Coat short and close.
4. An old male, 7′ 7″ long ; weight 121 lb. Head small. Coat furry, tail long and furry. Ground colour of body a pale fulvous grey. Spots small and few, even along the median line of the back ; many double

rosettes, with the inner circle consisting of spots and the outer not heavily marked but delicately pencilled.

The ear-spots are present, as in the tiger, but much less noticeable, perhaps because of the spotted coat.

Distribution

It has often been said of the leopard that (even within peninsular India) it has a much wider distribution than the tiger, being much smaller, more versatile in its hunting, more tolerant of the heat and less demanding in its requirements of cover, being well able to thrive in open country, in rocky hills and thorn-scrub.

That was the position 25 years ago. In the recent past the leopard has declined notably in open country and around human settlements in peninsular India, partly owing to the conversion of scrub to human uses and partly to having been shot out and poisoned. It is now to be found mainly in certain favoured localities, such as sanctuaries, and is almost or completely rare in many locations where it was common formerly.

Habits : Behaviour

The literature on the leopard as a big game animal is extensive and contains much evidence on its unpredictable variability, but meagre in circumstantial accounts of its habits. A male and a female are sometimes seen in a pair, as also a leopardess with young cubs, but the period of association between cubs and mother seems shorter than in the tiger ; perhaps the cubs grow up faster.

The size of its prey depends, naturally, on the size of the leopard. It is generally agreed that sambar stags and bull nilgai are left alone by leopards, but at Chilkanahatti (in Mysore State at present) a big leopard killed a bullock. Subadult and young sambar and nilgai are no doubt preyed upon, as also young gaur calves if they can be safely attacked. A leopard is not able to kill even a goat quickly, with a blow of its paw or one bite, as tigers do at times, and therefore it has to study safety in attacking the young of large animals. A small leopard on a fallen tree trunk was seen closely watching a herd of gaur in which there were 3 young calves ; seeing me (on elephant back) the leopard dropped into the grass below and seeing it, two gaur cows rushed towards it with lowered horns and the leopard bolted (TN 62 April 7, p.m.). On another occasion, 3 gaur cows topping a rise saw a big male leopard ascending the rise from the other side, and after a momentary halt and sharp, nasal snorts, rushed at the leopard with lowered heads and the leopard bolted (TN 59 Mar. 22, a.m.). In both instances, the gaur rushed at the leopard at a fast walk, not a gallop.

A small adult female, followed at a distance on elephant back, urinated repeatedly, rolled on her back on the ground with all four feet in the air, and when moving fast, melted into a grey blur (TN 63 Mar. 19, p.m.). The almost completely obliterative disruptive colouring of a leopard in tangled tall grass or thorn-scrub has been remarked upon by many observers, and is no doubt of value to an animal that is abroad so much by daylight (TN 63 Mar. 25, a.m.) ; however the remarkably disruptive effect of the coat when the animal is moving fast has not received the attention it merits ; unlike a tiger, a leopard crossing even open ground at a fast pace is difficult to follow visually, because the effect of movement is to create, not a grey form with contour sharpness, but a grey blur. I have noticed this both by daylight and by artificial light (spotlight) at night—the only other Indian animal that also gets blurred by movement is the porcupine, but that is no doubt achieved in part by the outbristling of the quills, and anyway is much less obliterative. This is perhaps of some value to the leopard in its getaway from large animals chasing it, such as gaur and tiger.

When moving away from men, or other animals such as gaur or elephants, leopards run or slink into bush cover or into tall grass, and often squat low in the cover, but are said to climb trees when a tiger is near or wild dogs on their trail. Tigers are their chief natural enemies ; many instances of wild dogs chasing leopards are on record. Occasionally, a leopard may seize a wild dog—I have heard of such an instance.

A very full account of the varied prey on which leopards subsist is provided by Dunbar Brander in his book. When hunting monkeys they sometimes climb trees, apparently to scare the prey into leaving the tree and seeking escape across the forest floor, when it can be seized : sometimes they hunt monkeys in a pair.

It is said that leopards are much less dependent on water than tigers. They do not lie up in water as tigers do, but drink regularly, particularly after feeding. As in the case of the tiger, a small water-hole or puddle will suffice for them, and in saying they can do without water, the human observers have apparently missed such inconspicuous sources.

Langur, macaques, barking deer, chousingha, chital, sambar and a number of birds (including the peafowl) sound alarm calls at the sight of a leopard, as at the sight of a tiger. Both the giant squirrel and the common striped squirrel also call at a leopard, the former in a more urgent variation of its normal rattling call, and the latter in an excited, sustained chirrup.

Unlike young tiger cubs, leopard cubs are highly vocal at times, till about 2 months old. Their call then is a repeated, plangent, long-drawn, rasping mew, and presumably addressed to their mother when she is not in sight, for it is not sounded when she is at hand. The grunt and snarl of the adult, as well as the peculiar call reminiscent of the thrust and return of a wood-cutting saw, are well-known.

The leopard's addiction to spitting and hissing like a wild cat, when expressing resentment (as when demonstrating at men) should be mentioned (TN 63 Mar. 25, 69 Oct. 3).

Leopards seem even more prone to residence within a limited range, when their requirements are met locally, than tigers.

THE JUNGLE CAT

Felis chaus (Güldenstaedt)

(Summary of field notes : Observation records : 22.

Locations : Tamil Nadu—Mudumalai Sa. : Orissa—Badrama : Bihar—Hazaribagh N.P., Palamau N.P., Karkatnagar : Madhya Pradesh—Kanha : Maharashtra—Taroba N.P.

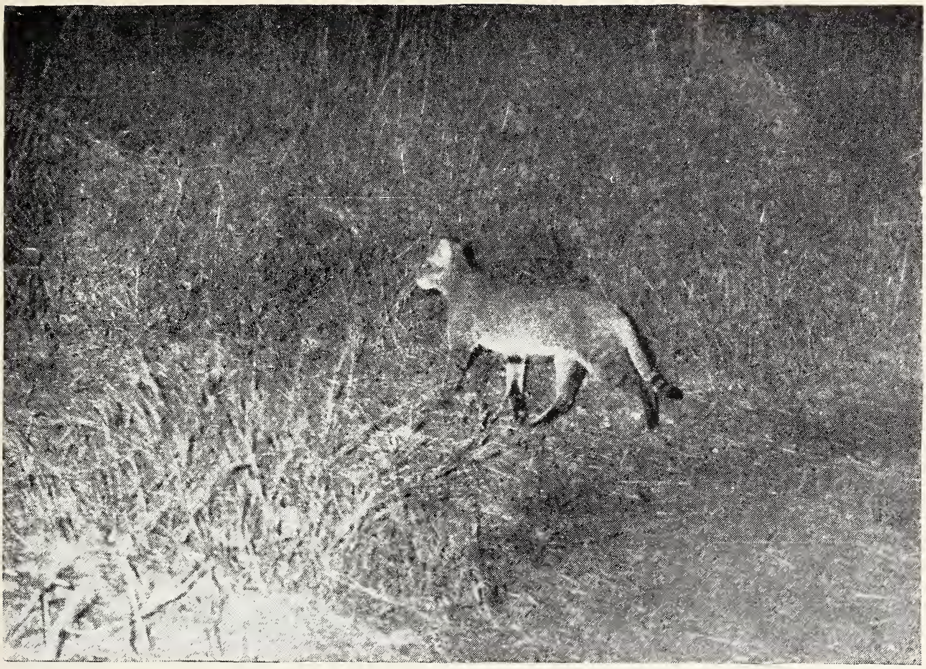
Photograph : B 9.)

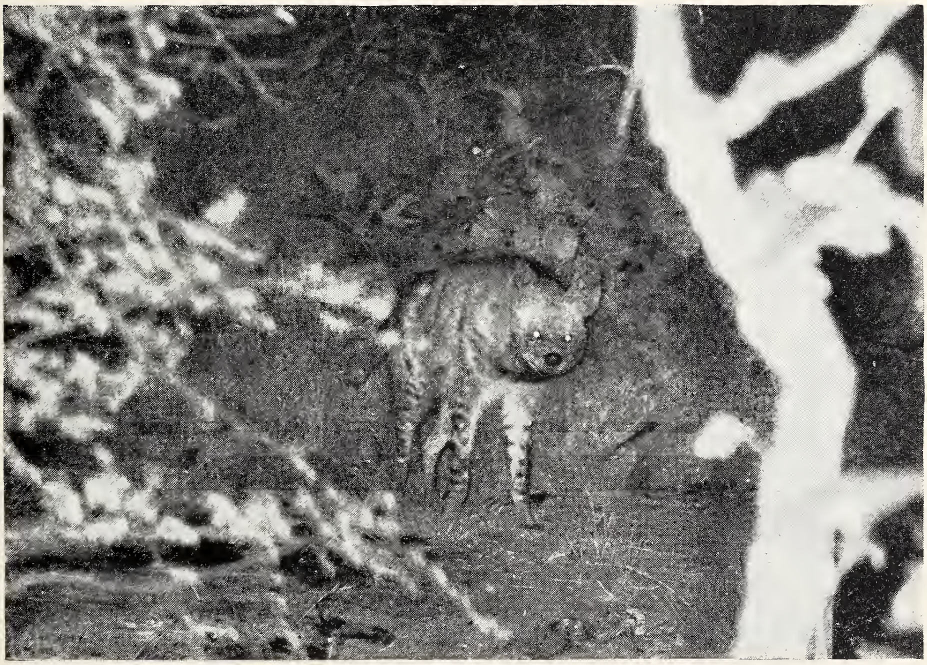
Domestic cats, run wild, are not uncommon in the scrub and forests around human settlements. Where there is some white or patterned stripes on the coat, these are easily told apart from the jungle cat, but the larger size of the latter, as specified in faunal literature, does not appear to be a reliable criterion for distinguishing between the two. In the identical location (for instance, the Hazaribagh N.P., Bihar) the animal is to be found of the stature and coloration of textbook descriptions, and also of the same colour but only about half the size of the larger animal, and these smaller specimens, closely observed, were seen to be quite adult. Inquiry of others likely to know about the possibility of hybrids between the feral domestic cats of India and authentic *Felis chaus* have yielded no definite information—the coloration of these smaller-sized Jungle Cats is substantially the same as that provided in faunas, except that there seems to be a greater admixture of brick red in the grey than in the descriptions, especially in the Taroba N.P. of Maharashtra. There is some variation in size even among the smaller animals seen, some being only the size of a big domestic tom (approximately 5-6 lb. in weight) and others somewhat larger. All cats seen in the forest of a general predominantly fulvous or reddish grey colour with no dark markings on the flanks, with the tail short and ending in a dark tip with a few rings above the tip, and pointed ears, edged with black or dark grey, have been taken as Jungle Cats in this report. (MR 68 Nov. 19, 20, 21, 24 ; B 69 Feb. 20, 70 Feb. 23 ; TN 70 Oct. 3).

Size : *Morphological characters*

Variations in size have already been mentioned. Some large specimens, of the size specified in faunas, were also seen (B 69 Feb. 14 : photograph B 9). In specimens seen, a dark line running down from the inner lower corner of each eye down to the nose (on either side) was observed. In subadults, there were dark bars on the inner aspects

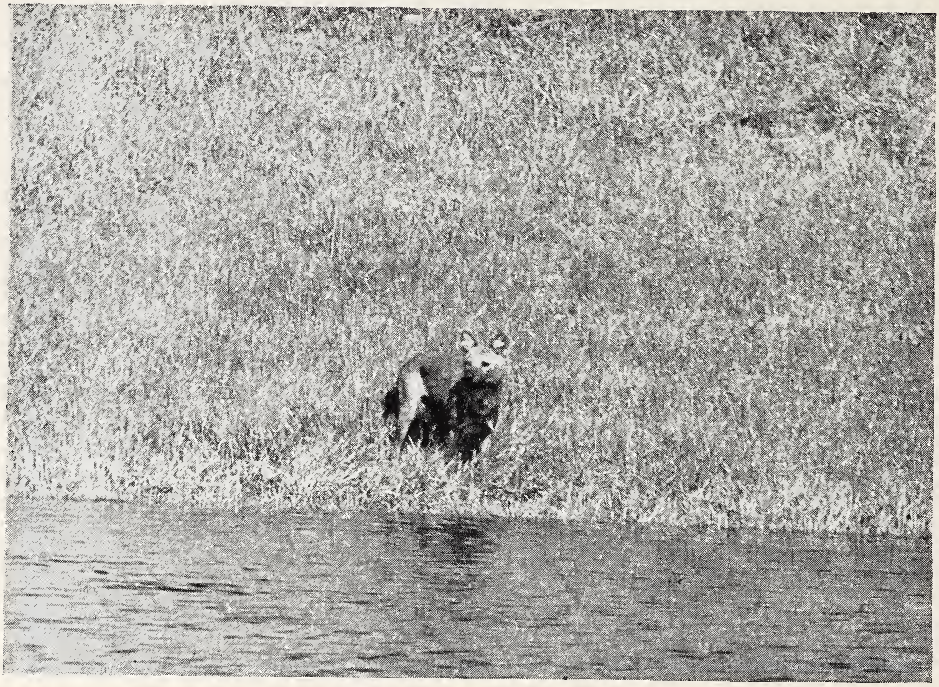
Krishnan : Mammals

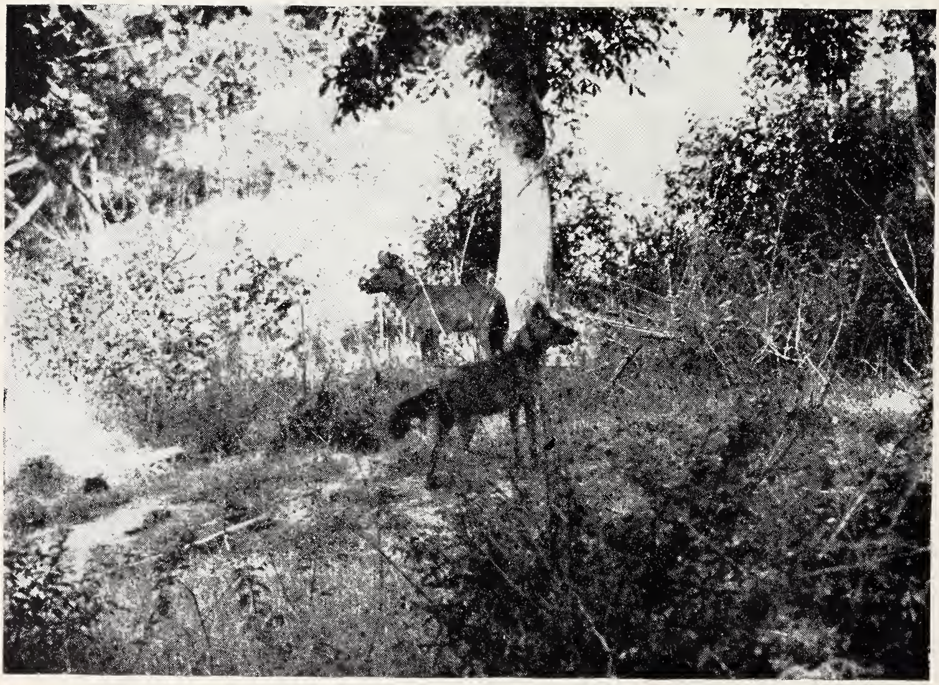




Above : BIHAR 1969 : HAZARIBAGH N. P. : February 14 — 8.30 p.m. : Jungle cat — B. 9 ; *Below* : BIHAR 1970 : HAZARIBAGH N. P. : February 4 — about 8.30 p.m. : Hyena — B. 23.

(*Photos : M. Krishnan*)





Above : KERALA 1970 : PERIYAR SA. : May 6 — a.m. : Wild dog — K. 28 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 22 — a.m. : Wild dogs — MY. 11.

(*Photos : M. Krishnan*)

of the upper half of the forelimbs and on the abdomen (B 69 Feb. 21 & 22, 70 Feb. 26).

Distribution

Throughout peninsular India, in open forests and scrub.

Habits : Behaviour

On occasion a cat was seen to pounce on something small on the forest floor, and to crunch it up, most probably a grasshopper or similar insect. 4 adults were seen crouched immobile in the open, near water, and in a bush near an artificial salt lick, evidently lying in wait for partridges, doves and other birds visiting the water and lick (B 68 Apr. 26, 69 Feb. 20, 70 Feb. 23, 70 Feb. 27 ; TN 64 Sept. 27, 70 Oct. 3 & 4).

Grown kittens were seen in the Palamau N.P., Bihar, in February 1969 and 1970.

THE SMALL INDIAN CIVET

Viverricula indica (Desmarest)

(Summary of field notes : Observation records : 18.

Locations : Tamil Nadu—Mudumalai Sa. : Orissa—Badrama, Simlipal Hills : Bihar—Hazaribagh, N.P. : Maharashtra—Taroba N.P.

No photograph.)

This is the common civet of peninsular India and mainly nocturnal.

Size : Morphological characters

Larger than the Common Mongoose, standing higher, and heavier-built. Length about 3 feet. Weight around 6 lb.

Distribution

All over the peninsula, in open deciduous forests and scrub jungles ; common around villages.

Habits : Behaviour

This civet was seen alongside forest roads at night, usually singly. A pair (probably mother and near-adult young) was twice seen on the periphery of the Taroba lake (MR 69 Nov. 20, 25). Although it climbs trees, it was always seen on the ground. In addition to feeding on small animals, berries and the like, it preys on insects, like beetles and grasshoppers.

This civet has an interesting history in the Deccan, where, till about 30 years ago, it was often tamed and given the run of the house, being an excellent ratter. The perfume, civet, is extracted from it, and formerly it was much valued as the provider of it, but for that purpose it was kept closely caged, the civet being rubbed off on the bars of the cage from its sub-caudal scent-glands, and scraped and collected.

THE COMMON PALM CIVET

Paradoxurus hermaphroditus (Pallas)

(Summary of field notes : Observation records : 7.

Locations : Bihar—Palamau N.P. : Madhya Pradesh—Shivpuri N.P. : Maharashtra—Taroba N.P.

No photograph.)

The 'toddy cat', so called from its tendency to drink the sweet juice from the pots of toddy-tappers (the name 'palm civet' has much the same derivation), is a much more arboreal animal than the civet, though it also hunts prey on the ground. It is nocturnal, like the civet.

Size : Morphological characters

About 3-foot 6-inch to 4 feet long, and around 8 lb. in weight. It is a low-to-ground creature that seems larger than it is because of its long, coarse, dark hair.

Distribution

All over the forest and scrub areas of the peninsula : not uncommon in urban areas.

Habits : Behaviour

The palm civet, like the civet, lives on small animals (including insects) and fruits, but finds its prey as often up a tree as on the ground : it preys on birds and raids their nests. In urban areas, rats seem to be its main prey. For years an untamed palm civet shared my tiled cottage and unkempt garden with me, and I have seen it hunting palm squirrels on my roof at night.

It is often found inside tree forests (MP 69 Mar. 31 ; MR 68 Nov. 21 ; 69 Nov. 25, 29 ; B 70 Feb. 21).

The eyes of few mammals reflect artificial light beams at night (such as a spotlight) as brilliantly as the palm civet's.

THE COMMON MONGOOSE

Herpestes edwardsi (Geoffroy)

(Summary of field notes : Observation records : 20.

Locations : Tamil Nadu—Mudumalai Sa., Pt. Calimere Sa. : Mysore—Bandipur Sa. : Bihar—Palamau N.P., Karkatnagar : Madhya Pradesh—Bastar : Maharashtra—Taroba N.P.

No photograph.)

The Common Mongoose is one of the few wild animals of India that most people know, in a somewhat anthropomorphic way as the killer of cobras. I have not seen a really big mongoose with a snake-charmer.

Size : Morphological characters

The male is larger than the female. The average length of an adult is 3 feet ; weight 3-4 lb.

Distribution

This mongoose is common all over the peninsula, and is essentially an animal of the open scrub.

Habits : Behaviour

This mongoose appears to be mainly diurnal. Wild mongooses were seen moving actively at all times of the day, even during the hottest hours. It is unreliable going by the activity cycle of tame animals, fed regularly, but most of the hunting seems to be done in the mornings and evenings. However, mongooses are met by night as well (MR 68 Nov. 19) : family parties of a mother followed by 3 or 4 young in a train, are usually crepuscular.

The mongoose is essentially a hunter, but its diet is varied with berries and other fruits, and it eats beetles, grasshoppers, birds and their eggs, lizards, snakes and frogs, as also small mammals like rats and mice. I have personally known it to kill a hare bigger than itself, and once saw a big mongoose carrying a fair-sized bird that looked like a stone-plover, considering the surroundings more probably a stone curlew (*Burhinus oedicnemus*)—MY 68 Oct. 19. At Point Calimere I noticed, shortly after dawn, numerous mongoose tracks leading from the littoral scrub to the foreshore and meandering along it, suggesting that crab-hunting at night was indulged in.

THE STRIPENECKED MONGOOSE

Herpestes vitticollis (Bennett)

(Summary of field notes : Observation records : 6.

Locations : Tamil Nadu—Mudumalai Sa.

No photograph.)

This large mongoose attains an almost otter-like thickness on occasion, though it is much smaller in proportion.

Size : Morphological characters

Much heavier than the Common Mongoose, though only about the same length (3 feet). Prater gives the weight at 7 lb. In the same area, some animals are much darker (TN 63 Mar. 17) : the distinctive stripe on the neck is visible in a good light even in such animals.

Distribution

Along the Western Ghats, in deciduous forests. In these, it is usually seen in swampy clearings, along watercourses, and in open scrub, though it certainly does enter tree forests also.

Habits : Behaviour

Although it hunts small prey, like insects and frogs, it also preys on animals as large as itself or larger. A stripenecked mongoose was seen chasing a young chital fawn in the scrub (TN 70 Sep. 20). A captive specimen I know was fond of bananas. A certain amount of vegetable food is also taken.

THE STRIPED HYENA

Hyaena hyaena (Linnaeus)

(Summary of field notes : Observation records : 4.
Spoor and call : 2.

Locations : Tamil Nadu—Mudumalai Sa. : Orissa—Simlipal hills, near Sambalpur : Bihar—Hazaribagh N.P., Palamau N.P.

Photograph : B 23.)

Prior to the period of this survey, I have seen the hyena now and again in fairly open forests interspersed with scrub. Very few were seen in the forested areas in which most of the work was done after 1959, but no doubt they were there. Being mainly nocturnal, and going about in a pair or by themselves, they are seen seldom, and then only by chance, in the course of night drives along forest roads. No attempt was made during the survey period to locate and observe hyenas.

Size : Morphological characters

The enormously powerful, bone-cracking jaws, the fall off to weak-seeming hind quarters and legs from the strong forequarters, and the dorsal crest of thick, long, fine hair are the main physical attributes of the hyena. Prater gives the height at the shoulder at 3 feet, and a weight of 85 lb. for a male. The spoor is unmistakable, with the imprint of the big forefeet so much bigger than that of the compact hind feet.

Distribution

The striped hyena has a wide distribution in Asia, and Africa. In peninsular India it is found both in forests, and more commonly in rocky, ravine-cut, bush-clad country.

Habits : Behaviour

Well known as a carrion eater and as a feeder off the kills of other animals, the striped hyena in India has not received the serious attention of naturalists. There are records of its appropriating a leopard's kill, driving off the legitimate owner of the kill—these are interesting, in that a fair-sized leopard may kill a big dog the size of a hyena, and suggest that the hyena does put its great jaw-power to aggressive or defensive use on occasion. There are also records of its carrying away dogs, and occasionally, infant animals and even children. As against this when hunted with dogs it has been known to sham dead instead of fighting its way clear, enduring the worrying and the bites of its hunters. Col. R. W. Burton assured me that taken young and tamed, it is quite dog-like in its attitude to men. Zoo specimens often get quite attached to their keepers, and others they know.

The vocalisation associated with the hyena is its discordant, cackling ' laughter ', which seems to be indulged in when it is excited. It also comes out with a high, nasal whine that tails off to a whimper, similar to the whine of a dog ' calling ' a man, when trying to attract attention. In 1955, a hyena in the People's Park at Madras was deeply attached to the late B. V. Ramanjulu, who was then the Superintendent of the zoo. On several occasions I have been a witness to this hyena scenting him, when he was invisible to it, and calling to him with loud whines, which would change to a staccato cackling when he came up and stroked it. Hyenas have a very fine nose.

Another sound commonly used by a pair out on a prowl, and separated from each other by a short distance, is a high, querulous ' kow ', somewhat long-drawn and declining in volume. I investigated this call, often heard at night along a stony nullah near Krishna Nagar in Sandur (now in Mysore State) and on two occasions was able to observe the hyena calling : the call was answered by its mate, from about a furlong away.

THE JACKAL

Canis aureus (Linnaeus)

(Summary of field notes : Observation records : 25.

Locations : Tamil Nadu—Mudumalai Sa., Pt. Calimere : Andhra Pradesh—Pakhal Sa.: Orissa—Tickerpara, Simlipal hills, Chilka : Bihar—Hazaribagh N.P., Palamau N.P. : Maharashtra—Taroba N.P.

No photograph.)

No attempt was made to locate and study jackals specifically during the period of this survey, but prior to it and in rural localities, I have had opportunities to watch them closely.

Size : Morphological characters

Prater gives the height as from 15-17 inches and the weight as from 17-25 lb., and adds that animals from North India are larger and heavier. Perhaps he means the sub-Himalayan areas, but neither in the northern parts of peninsular India nor even in U.P., north Bengal (near Bhutan) and Assam were the jackals seen noticeably larger than in the South. The largest jackals I have seen were in the Pulneys.

Very dark, almost black jackals (said to be not uncommon in N. India) are quite rare in the peninsula, but occur in the south-west. Animals almost entirely tawny are also seen occasionally.

Distribution

All over the peninsula : commoner around forest-side villages than in forests.

Habits : Behaviour

A great deal has been written about jackals as scavengers and as the camp-followers of tigers. It is significant that the ' pheal ' of Anglo-Indian shikar literature is said to attach itself to tigers and not to leopards—the latter prey on jackals.

Jackals living along the coastline are much given to hunting crabs at night along the foreshore (TN 68 Dec. 12). Apart from feeding on carrion when it is available, they hunt whatever they can overcome, from field mice to the fawns of chital. When hunting larger prey, sometimes they may run in a pack, but usually they hunt alone. Among the fruits eaten are ripe mangoes, the ripe drupes of the lantana, and *Zizyphus mauritiana.*

At sunset jackals usually come out with a concerted howling, one animal starting the howling which is taken up by others near it. The purpose of this vocalisation is not clear, but it is probably an assembly call. This evening chorus of jackals, once one of the most familiar sounds of the Indian countryside, is no longer to be heard in many of the areas where it was common. No doubt the occupation of the plains country by humanity is partly responsible for this, but since this chorus is mainly a feature of jackals living around human settlements, this cannot be the explanation of the decline of the familiar noise.

THE DHOLE OR THE WILD DOG

Cuon alpinus (Pallas)

(Summary of field notes : Observation records : 25.

Locations : Kerala—Periyar Sa. : Tamil Nadu—Mudumalai Sa. : Mysore—Bandipur Sa. : Madhya Pradesh—Kanha N.P. : Maharashtra—Taroba N.P.

Photographs : K 28 MY 11.)

The history of human hostility to the wild dog in India during the present century is both interesting and significant, as showing a strong biotic bias that is independent of cause-and-effect reasoning, motivated largely by unverified prejudice, and sentiment. No other animal has incurred the antagonism of man without doing him any demonstrable harm. No instances are on record of wild dogs having killed or injured men in the many brushes between them ; though they have been known to kill cattle on occasion, these killings are so few and far between that they may be ignored and, moreover, have never been cited as a reason for outlawing the predator and, being a thoroughgoing carnivore wild dogs have never done any harm to crops. Moreover, being a comparatively small animal whose head provides no worthwhile trophy and whose pelage loses its lustre with death, it has never been considered a game animal. But still there has been a reward on the head (and brush) of the wild dog till recent times and even today the dominant impulse of men with guns on seeing the animal is to shoot it.

Only one justification has been adduced for this implacable hostility and it is valuable in its way as showing the sustained and ubiquitous interest of men in hunting the very animals that the wild dog hunts, especially deer—it is a hostility sustained by a sense of competition. Hunters proceeding to some area noted for its game, to shoot, have found the game animals wary, elusive, and scattered, and have attributed this scarcity and vigilance to the earlier visit of wild dogs to the area. In this they are probably less correct than they think. If, as it is repeatedly asserted in shikar literature, all the deer and other herbivores at once abandon their homes and shift the moment wild dogs appear in their area (presumably to near-by areas where they are safe from wild dogs) it is difficult to understand how the wild dogs are able to find prey or why they (among the most persistent followers of scent trails) do not follow their retreating prey.

And it is not as if these sportsmen did not know two highly relevant aspects of this question, first the fact that wild dogs and their prey are often found in the same area and second that for thousands of years the two had coexisted without the prey species having died out.

There are records of sportsmen having seen wild dogs lolling on the ground in plain view of chital and sambar which just ignored them, since the dhole were not hunting. To provide reason for raising the government reward on the head of wild dogs, Glasfurd puts forward the theory that they have suddenly increased in numbers. The periodic fluctuations in the wild dog population of an area, the apparent sudden increase and subsequent sudden decrease, which cannot be adequately explained entirely by influx and efflux but is also caused by actual increase and decrease in numbers, has been selectively cited to show that these ‘ vermin ’ should be sternly put down. The role of wild dogs in maintaining the balance of nature has been consistently ignored, though F. W. Champion makes out a weak case for them. The truth seems to be that human hostility to the wild dog is largely based on compassion for their victims, on the ruthless and piecemeal killing methods of the predators, which being small compared to their prey are sometimes unable to kill them swiftly, though they do attack in numbers and pull down and kill the prey quickly quite often.

Size : Morphological characters

Size and even colour vary somewhat with locality and individuals. A comprehensive account of the appearance and other characteristics of the dhole is provided in a note by Col. R. W. Burton (*JBNHS* 41 (4) : 691-715) which sums up most of the information available up to 1940. Generally speaking, the dhole is from 17 to 22 inches in height and from 30 to 45 lb. in weight, with what dog-fanciers term a red coat : the brush, carried below the level of the back, has a terminal tuft of long black hair, sometimes with a core and tip of white hair. In an old dog, the back may be dark and grizzled, very much in the patterning of a jackal's back (TN 63 Sep. 30) : a little white may be found on the toes, or on the chest or throat (MP 69 Mar. 14). In profile the face is somewhat downfaced, and the muzzle deep, both characteristics shared by no breed of Indian domesticated dog.

The genus *Cuon* is distinguished from *Canis* (the genus of the wolf, the jackal, and all domesticated dogs) mainly by there being one molar less on each side in the lower jaw, and the bitch having about 14 teats instead of 10. The close resemblance of the dhole to red-coated countryside dogs (red, warm sienna and brown are the colour of countryside dogs of unmixed blood, termed ' pariah ' by canine experts) has been remarked by many observers. Forsyth (THE HIGHLANDS OF CENTRAL INDIA) was confused by the similarity of the tribal pariah dogs of the Upper Narmada forests to the dhole, and thought those dogs were descended from the latter. Burton, arguing the case further in his note, says that jackals have been known to interbreed with the dhole, and also with domesticated dogs, and cites the instance of ' a wild dog bitch with her two pups, sired by a jackal in the Mysore Zoo in November 1930 ', and sees no reason why interbreeding between dhole and domesticated dogs should not result in a breed of red-coated domesticated dogs. Apparently the extreme likelihood of the progeny of such far-fetched matings being infertile was not considered by him. In view of the taxonomists being almost certainly entirely correct in their separation of the genus *Cuon* from *Canis*, the name ' wild dog ' seems a misnomer for *Cuon alpinus* and it seems advisable to adopt the other vulgar English name (derived from Indian languages) and term this animal ' dhole ' : the desirability of keeping such derived names (gaur, langur and barasingha provide other examples) pure by interpreting them to include the plural as well as the singular (as they include in the Indian languages from which they are derived) may also be mentioned here.

Distribution

Within peninsular India, the dhole is essentially a forest animal, and is not found in open country.

Habits : Behaviour

A great deal has been written about the destructiveness of the dhole, and also its method of hunting. Although usually running in packs and parties, it may also hunt alone, as when breeding, and at such times it is probably looking for small, easily available prey, such as hares and field rats, though it can pull down a chital hind or a small pig single-handed. A single male was observed regularly quartering an extensive patch of scrub at an easy run, with its head held high, scanning the ground in front of it ; occasionally it took a high jump to look over the bushes limiting its vision (TN 62 Sept. 26). Packs usually go for large animals, such as chital, sambar or pig. Although it is known to kill cattle (especially young animals) once in a way, inquiry of the herdsmen in the Tamil Nadu and Mysore forests around the river Moyar, where cattle are grazed in thousands and dhole are common, elicited the information that as predators affecting cattle they were negligible : one such inquiry was made in Bandipur (MY 68 Oct. 7). Most of the accounts of dhole hunting go to show that they follow fast-running prey, usually much larger than themselves, relentlessly by ground scent, tiring their quarry out in the course of a long run and then, having practically run it to a standstill, tear it down piecemeal. No doubt they do hunt in this manner, where the ground favours such hunting, but more often the run is short, only about half-a-mile or so, and the quarry is in plain view all the time. I have observed two such killings, and one of them is mentioned in the field notes (TN 63 Sep. 30). In this instance, three or four of the pack came out to the scene of the kill in advance, before the rest of the pack stampeded a large herd of chital, and drove a section of the herd across a hollow on to comparatively open ground, the outlying sentries preventing the deer from escaping to bush and tree forest beyond. Having cut off one animal (a young stag with antlers just shed) the dhole concentrated on it (though one of them also chased a hind, on its own, the hind escaping), taking advantage of its curved line of flight to get near it by short-cuts. Then one of them launched an all-out attack, a frenzied, flat-out scurry for the bite, with its effort punctuated by its rasping intakes of breath ; when it failed, it fell back and at once the attack was taken up by another dhole. There is no attempt to pull down the quarry in such attacks, but only to snatch at it, the momentum of the much heavier prey serving no less than the jaw-power of the dhole to tear out a chunk of flesh and hide. A big stag at bay, with its back so protected by some natural feature that an attack from the rear is not possible, may probably be able to fend off the attackers with its antlers: in such a case, the dhole give up the hunt, or much more usually just surround the prey and wait, and when the tension of the situation causes the deer to break away and attempt escape by flight, it is once more exposed to attack.

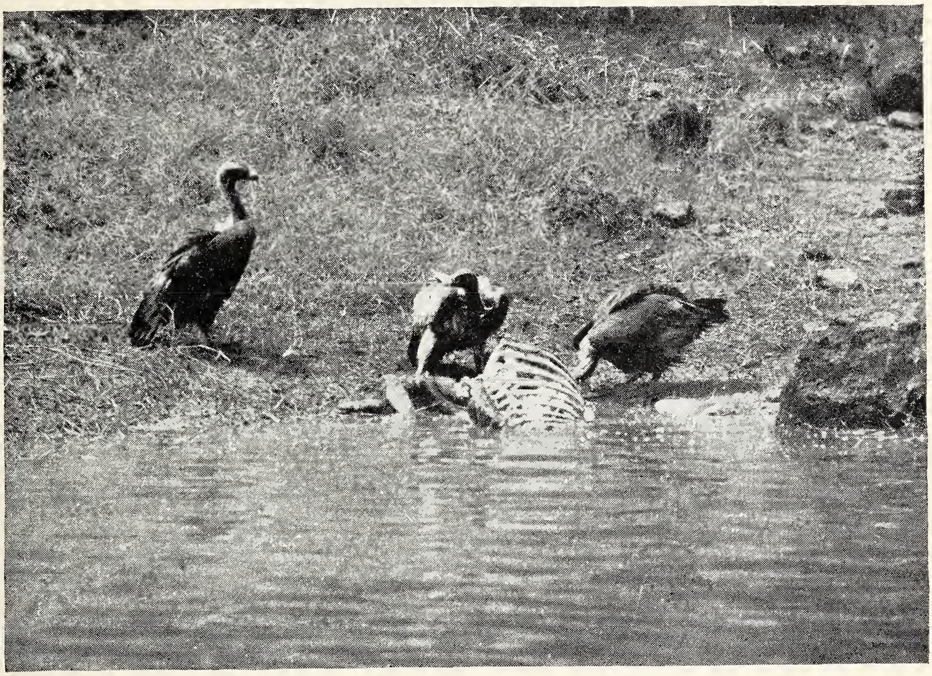
Dunbar Brander says that dhole seldom hunt at night. This seems substantially true, for sight seems to be every bit as important to them in hunting as scent: they keep in touch with the members of the pack following the quarry by means of high, whistling whines when pursuing the prey through obscuring bush cover, and kill it only in comparatively open ground, guiding their attack by sight. However, hunts at night have been recorded and F. W. Champion has a night-photograph showing some dhole smelling the ground : they are active by night as well.

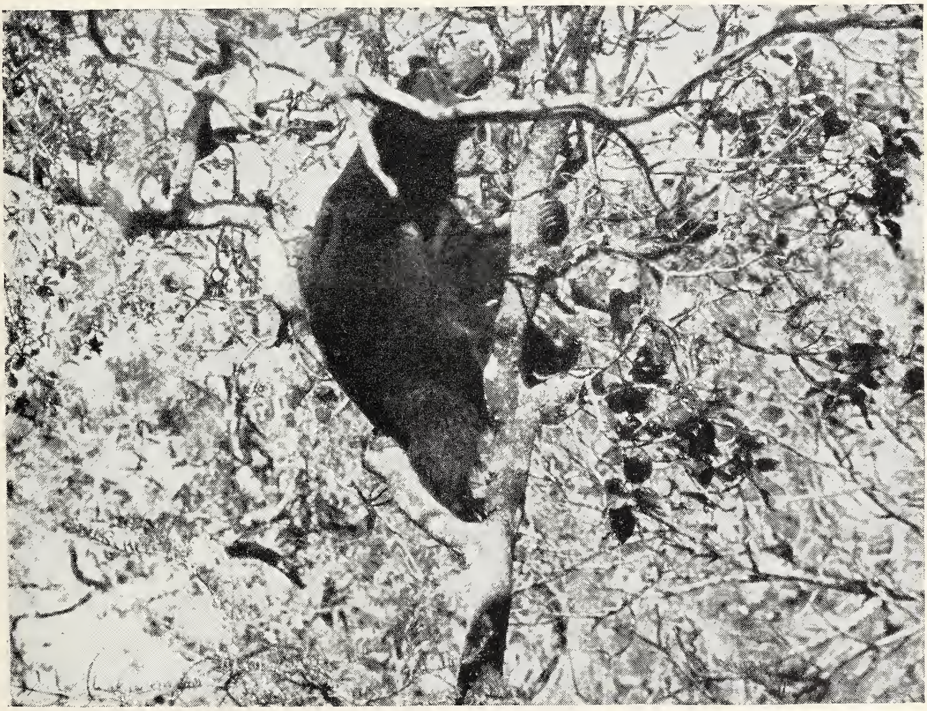
Dunbar Brander says he has never known them remove the stomach and intestines from a kill, and that kills from which these had been removed were probably the property of a leopard, misappropriated by dhole. In both the kills actually witnessed, one of a sambar hind killed right in front of my eyes in the course of a run over 100 yards (this is not recorded in the field notes) and the other of a chital stag which I saw being chased, heard being killed, and a few minutes later saw as a half-devoured kill, the guts had been removed as also the tail, and both flung feet from the body (TN 63 Sep. 30). In his note, Burton relying on Inverarity says that the eyes are invariably consumed at once (if not torn out earlier) as soon as the kill is made. In both the instances of personal observation cited above, the eyes were untouched, though more than half the body had been eaten by the time I inspected the kill.

The vocalisations of this normally silent animal are discussed in Burton's note. Among the vocalisations I have heard are the well-known whistling whine when the dhole were pursuing prey in bush cover (MY 68 Oct. 14; TN 69 Oct. 4), evidently sounded by the animals nearest the quarry as a guide to the rest of the pack, a short, interrogative bark and a loud, unearthly cackling which served to reassemble scattered dhole (TN 63 Sep. 30). Dhole jump high to scan the surroundings, and also go up elevations to peer over the crest (MY 68 Oct. 22 : MP 69 Mar. 14).

Burton mentions the inability of a dhole to spot him, sitting in a machan above it, from his sounding a whistle and blowing on a signal horn, and from this says that the dhole (and some other animals) are not quick in spotting things well above the level of their normal preoccupation with the ground. My experience has been quite otherwise. Few animals are quicker at pinpointing even slight sounds even from a treetop seat (MY 69 Oct. 21).

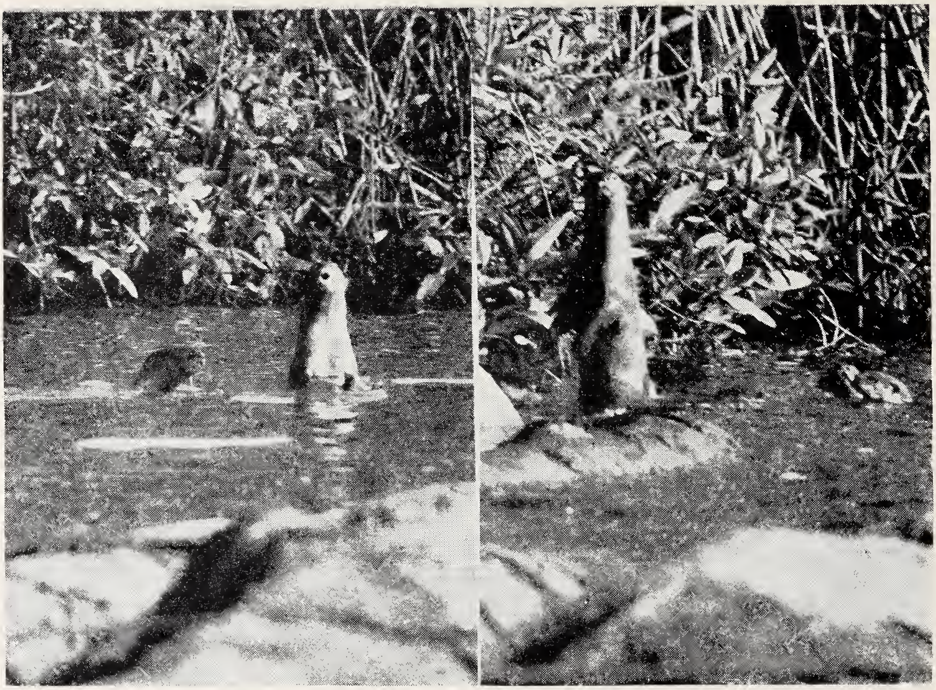
Krishnan : Mammals

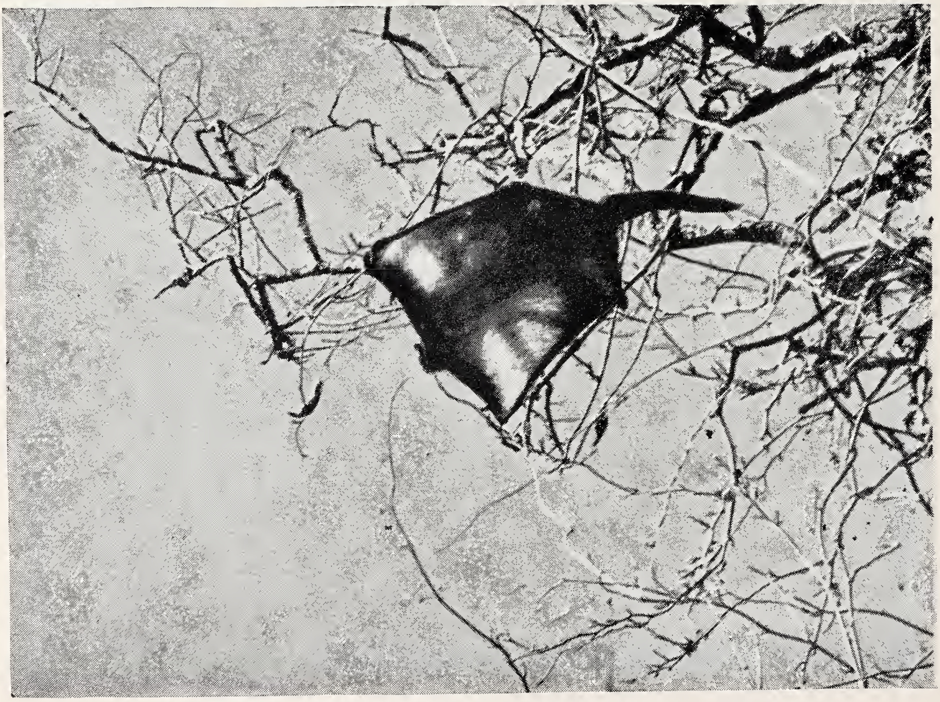




Above : KERALA 1960 : PERIYAR SA. : April 17 — p.m. : Vultures feeding on a wild dog kill : (sambar) — K. 8 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 14 — a.m. Sloth bear eating mohwa flowers — TN. 9.
(*Photos : M. Krishnan*)

Krishnan : Mammals





Above : KERALA 1959 : Quilon backwaters : June 1 — a.m. : Otters standing up in the water to look and hiss at me — K. 1; *Below :* TAMIL NADU 1963 : MUDUMALAI SA. : Kargudi : March 20 — a.m. : Large Brown Flying Squirrel gliding — TN. 23.
(*Photos : M. Krishnan*)

Many observers have recorded the indifference of deer and other prey species to the sight of dhole when the latter are not hunting : among them R. G. Burton (SPORT AND WILD LIFE IN THE DECCAN) and Dunbar Brander—see also MP 69 Mar. 14. E. R. C. Davidar (*JBNHS* 67 (1) : 102-103) records seeing two sambar stags walking towards and dispersing a pack of resting dhole.

The tendency of these animals to kill near the water has been noticed by a number of observers, and a few theoretical explanations have been provided. One chital killed at Theppakkadu in 1970 was said to have been actually brought to the water by the dhole, after having been killed higher up the bank of a river (TN 70 Oct. 5).

No satisfactory explanation is available for the sudden increase in the numbers of dhole in a forest area, usually followed by a no less sudden decline, or even disappearance from the area. It has been suggested that the increase follows a year of plenty, when the prey has been abundant and breeding prolific, and the decrease is caused by epidemics—it is known that dhole succumb in numbers to epidemic infections (MY 69 Oct. 24). That does not seem to adequately explain the phenomenon. The truth seems to be that dhole, while usually found in certain areas which suit them (such as Masinagudi and Bandipur), are much given to wandering, and travel far in search of feeding grounds when prey has declined in the haunts in which they were originally. It might still be found that there is a hard core of truth to Kipling's ' Red Dog '.

In the Masinagudi area of the Mudumalai Sanctuary, the role of the dhole as a predator helping in maintaining the balance of nature can be seen. Long known for its elephants and chital, in recent years the wild life of the area has been widely affected by the setting up of the hydel project at Moyar and the development of Masinagudi and surroundings from an obscure rural hamlet to a place with a sizeable population and widespread agricultural activities. Chital and pig, it seems likely, would have overrun the place but for the salutary influence exercised on them by the dhole, which keep them in check not so much by killing them in numbers as by periodically scattering and harrying them, thereby contributing in a small but significant manner to curbing their breeding.

THE SLOTH BEAR

Melursus ursinus (Shaw)

(Summary of field notes : Observation records : 5.
Footprints and claw-marks : 3.
Locations : Tamil Nadu—Mudumalai Sa. : Maharashtra—Taroba N.P.
Photograph : TN 9.)

During the survey period, although much time was spent in the hill forests where bears could be expected and were formerly common, I saw only 5 bears and the footprints of a few more. Bears are still to be found in certain localities, as around some forest-side sugarcane growing areas in Mysore, and it is true that no special attempt was made to see them by visiting such areas. However, the meagreness of the sight records in the field notes only confirms the impression that had been growing upon me prior to 1959, that in most forests where bears were once common they now survive only in place names such as Bear Shola and Karadi Kolla, or are so reduced in numbers as to be rare. No bears were seen in the course of many night drives, except for one fleeting glimpse of a bear near Pandrapauni village in the Taroba N.P. (MR 68 Nov. 25). Collateral evidence of this decline is provided by the fact that in South India the itinerant man-with-the-performing-bear, once so common, is almost as rare as the bear itself now, though his fellow entertainers are still to be seen in the countryside, such as snake charmers and jugglers.

Size : Morphological characters

The Sloth Bear, the only bear of the peninsula, is so different from other bears that it has been assigned to a genus all its own. The long, strong white claws, the ample lips, and harsh, shaggy coat are characteristic. Height varied from 2 to 2¾ feet, and weight from 140 to 320 lb. ; in the adult, the male is larger than the female.

Distribution

Textbook accounts of distribution are now obsolete. This bear is no longer to be found in many forests where it was known even 25 years ago.

Habits : Behaviour

This bear is an expert climber, as much at home up a tree as on the ground. The fare is varied, and it is truly omnivorous ; jungle fruits such as the jamun, the ber, the bael, species of *Grewia*, species of *Diospyros*, *Cassia fistula*, the flowers of the mohwa, honey, grubs, insects (especially termites), and the tender shoots of grasses are all eaten ; its habit of raiding sugarcane in places is known, but it is not generally known that it eats much grass (TN 59 Mar. 15). Prater says that termites constitute its staple fare, and no doubt this is largely true, but what a sloth bear eats is largely a question of season and local availability, and we have really no idea of the great variety of its diet. However, it is recognised by all naturalists that it works hard for its living. Its addiction to the sweet palm-juice in the pot of toddy-tappers has been recorded by many observers. It needs water, and is never found away from some source of drinking water.

Two cubs are the rule, and the mother bear's attachment to her young is well known. Bears are long-lived, and are slow breeders. They are much more diurnal than is generally appreciated, and where undisturbed are sometimes out even during the hottest hours of the day.

THE OTTER

Probably *Lutra perspicillata* (Geoffroy)

(Summary of field notes : Observation records : 5.

Locations : Kerala—Quilon, Periyar Sa. : Bihar—Hazaribagh N.P.

Photograph : K 1.)

Even the specific identity of the very few otters seen, fortuitously, is not certain, but most probably it was the Smooth Indian Otter. Surprisingly, an otter was seen (and otters are to be seen) in the Hazaribagh N.P. even in summer, when there is hardly any source of water : the animal seen was evidently subadult, and ran ahead of the jeep at night for nearly 100 yards (B 68 Apr. 19).

Otters enjoy no protection, except perhaps in sanctuaries (where they are seldom found), and are destroyed by fishermen where found : in one instance, a holt was blown up with dynamite, destroying the otters within (K 59 June 1). Besides fish, they also feed on freshwater tortoises (K 70 Apr. 23). A party of 4 adults was seen playing in the Moyar river (TN 70 Oct. 3).

THE RATEL

Mellivora capensis (Schreber)

This is the one animal I have tried hard to see without success in the forests of peninsular India. The only time I saw it was when a big ratel ran in front of the jeep one evening, at the Hazaribagh N.P. (B 70 Feb. 4). Although it is nocturnal and therefore seldom seen, and although it is never found in numbers anywhere, I believe it does have a wide distribution in the peninsula. Many different tribals of whom I made inquiries did not know the animal at all, though drawings and photographs of it were shown to them and a description provided. The few who did know it, said it was rarely that it was seen, and then only by chance : they could not tell me anything about its fondness of honey. No doubt it is as much given to raiding honey combs in India as it is in Africa : a captive ratel I used to know had a decided sweet tooth.

THE LARGE BROWN FLYING SQUIRREL

Petaurista petaurista philippensis (Elliot)

(Summary of field notes : Observation records : 2.
Locality : Tamil Nadu—Mudumalai Sa.
Photograph : TN 23.)

There was little scope for observing this nocturnal animal in the tree forests of the Mudumalai Sanctuary, where it was twice seen by day in treetops, evidently having been bolted from its sleeping hole. Many years ago, in Yercaud in Tamil Nadu, I had exceptionally favourable opportunities for watching 4 of these squirrels which resided close by where I was staying, on three consecutive nights, when the moon was bright.

Size : Morphological characters

This is the largest of our squirrels, being slightly larger and heavier than the giant squirrel. The colour is vandyke brown, at times touched with sepia, and the parachute membrane is almost translucent in flight, when stretched between the legs on either side (Photograph TN 23). The tip of the furry tail is not covered with long hair and has a sharply constricted appearance—this is shown in the photograph. In repose and while moving about the treetop or ground, the elastic parachute is retracted against the sides and is hardly visible. Both on the ground and while going up tree boles, the squirrel has a hobbling run. The eyes are large, dark and protuberant, and evidently meant for night vision. The claws are hard and sharp. An adult, killed by tribals, weighed 3 lb.

Distribution

The tree forests of the peninsula : it seems to prefer deciduous forests to true evergreen forests.

Habits : Behaviour

This squirrel is entirely nocturnal. It spends the day within its bolt-hole in wood, a round-mouthed hole from 15 to 40 feet up the bole of a tree : from this entrance, a vertical shaft goes down the bole, ending in a comfortable chamber, in which the squirrel sleeps : it is said to sleep curled up, resting on its flat head. The presence of fresh claw-marks around the entrance-cum-exit hole in the side of the tree is a reliable token of the squirrel being at home, but it may have several bolt-holes in a locality and may occupy different sleeping trees on different days.

Perched high up a tree, it may sit high, with the tail pendent, and then looks like some dark, arboreal cat, its appearance justifying the Kannada name for it, ‘ flying cat ’. At other times it crouches low, especially when about to take off for another tree, with its tail lifted over its back so that the tip is right above the head. It usually takes a short, hobbling run before it launches itself into the air, to gain momentum for the glide. The glide is flat in trajectory and the animal loses height with progress through the air till it is a few feet from the tree it is making for, when it rises in the air with the body parallel to the bole of the tree : this stalling brakes the momentum of the glide and enables the squirrel to land very softly on the tree. It is at this moment that tribals, hunting it, usually kill it, by means of a short, heavy club thrown at it.

Besides men, the larger forest owls prey on these squirrels.

These squirrels seem to be sociable. On emerging at night, they usually come out with a booming call, which seems to attract their fellows in the neighbourhood, and some playful gliding is indulged in in company before they settle down to feed.

Besides tree bark, fruits and nuts, leaf-buds, insects (including termites, whose crusts on the boles of trees are broken with the tip of the nose to expose the insects within), and fresh grass is eaten. I have seen this squirrel feeding on newly sprouting grass on the ground. When on the ground, it runs up a tree some 20 feet before taking off for another tree. Glides of 50 yards and a little longer are common (TN 63 Mar. 20).

I saw a large flying squirrel, along with its grown young which was almost as big as itself, bolted from the same hole many years ago by tribal hunters. Apparently the young stay with their mother till almost full grown.

THE INDIAN GIANT SQUIRREL

Ratufa indica (Erxleben)

(Summary of field notes : Observation records : 24.
Alarm call heard without squirrel being seen : 6.

Locations : Tamil Nadu—Mudumalai Sa. : Mysore—Bandipur Sa. : Orissa—Barmul, Raigoda Sa.: Madhya Pradesh—Churna.

Photograph : TN 53.)

This squirrel, fairly common in deciduous forests, was seen oftener than the field records show, during the survey period. For instance, I saw it and heard it in the forest around the river Koel, in Bihar, though this was not noted down.

Size : Morphological characters

A large, strikingly handsome squirrel seen from near, with the fore-face, extremities, the tip of the tail, and the belly cream, and the head and body brilliant chestnut and black. However, it is not conspicuous in the treetops, and is oftener heard than seen. Overall length is about 3 feet, of which more than half is bushy tail. Weight of adult, around 2½ lb.

Distribution

The deciduous and semi-evergreen tree forests of the peninsula. Not found in open, dry forest.

Habits : Behaviour

This squirrel is diurnal and highly arboreal. It spends the night in big globular nests of twigs right at the top of trees, and the young are also born and nursed in such nests. It seems to have an established territory, and has several sleeping nests within this territory ; an adult male was observed chasing another in the vicinity of 3 or 4 nests late in the evening, and was probably chasing an intruder off its territory (TN 59 Mar. 12).

When leaping from treetop to treetop through the air, the body is compressed dorso-ventrally (TN 62 Apr. 5) : a leap of nearly 10 feet may be taken, but not much more than that.

A number of leaf-buds, leaves (especially fresh leaves) and twigs are eaten, among them *Anogeissus latifolia*, *Garuga pinnata*, *Lagerstroemia lanceolata* and *Grewia tiliaefolia*, (TN 62 Mar. 14 and 25, 69 Sep. 16). The fruits of teak, *Terminalia tomentosa*, and *Aegle marmelos* are eaten in season, the rasping of the squirrel's incisors on the hard shell being audible a hundred feet away. I have seen this squirrel breaking up the crust of termites on tree boles with its nose and feeding on thei nsects, in the same manner as other squirrels. No doubt grubs and insects are also eaten. It is fond of the nectar of the red silk-cotton as also the immature fruits of this tree (TN 66 Apr. 16). A position frequently assumed while feeding is to hang head downwards by the hind feet, using the forefeet to convey fruits or leaves to the mouth. While resting, this squirrel often relaxes on its belly across a stout twig, with the hind legs and tail hanging down on one side, and the forelimbs and head on the other.

The metallic, rattling call is used both in intraspecific communication and as an alarm : the tempo is audibly more excited when it is sounded in alarm, and both leopards and jungle cats provoke the call.

Among the predators that prey on this squirrel may be mentioned the crested hawk-eagle (TN 59 Mar. 18).

Young were seen in September in the Mudumalai Sanctuary (TN 70 Sep. 25, Oct. 1).

THE INDIAN PORCUPINE

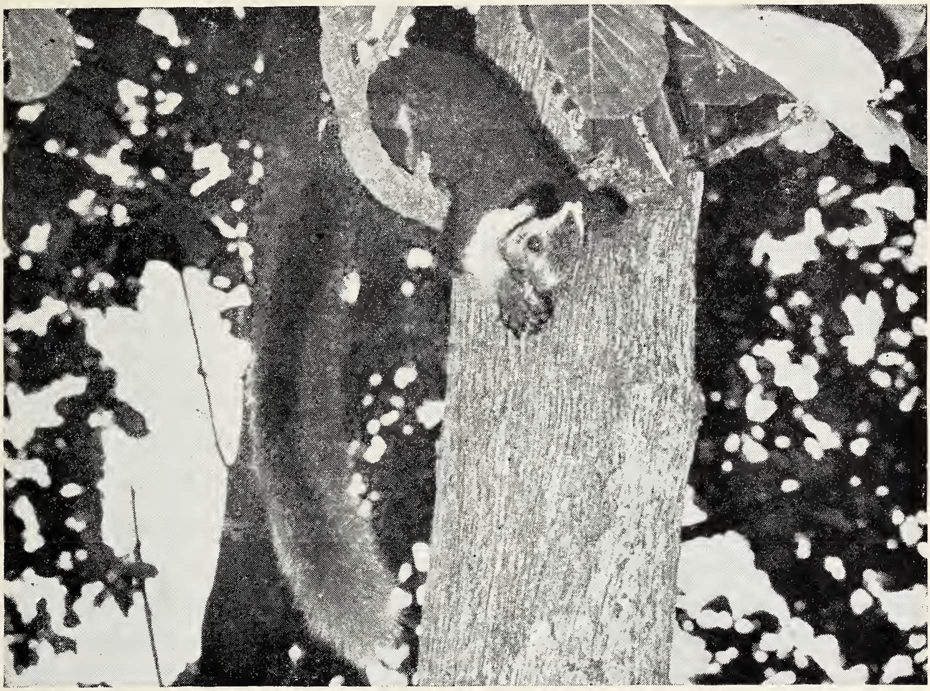
Hystrix indica (Kerr)

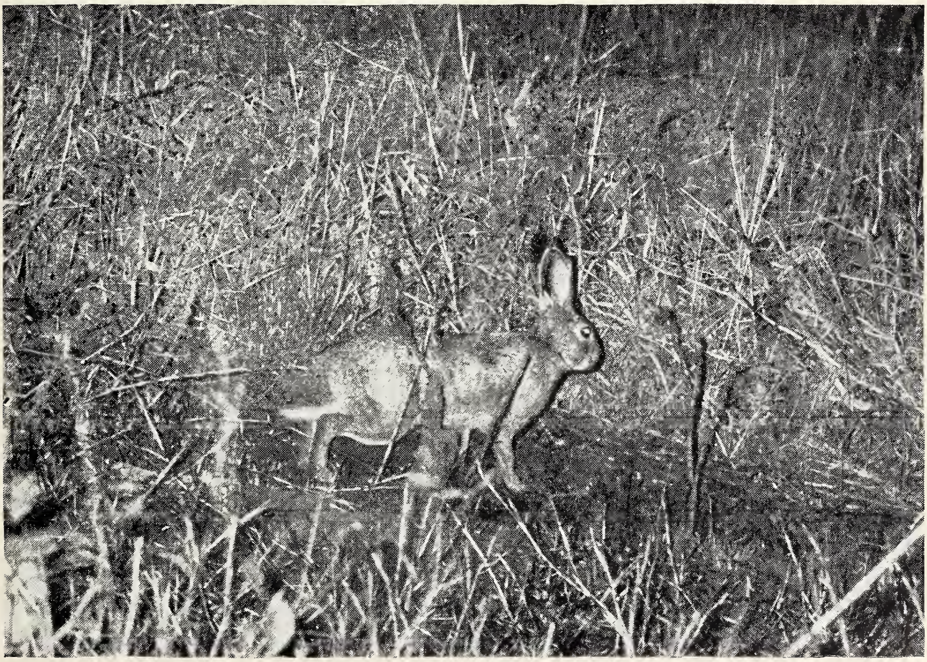
(Summary of field notes : Observation records : 8.

Locations : Tamil Nadu—Mudumalai Sa.: Orissa—Raigoda Sa.: Bihar—Hazaribagh N.P., Palamau N.P.: Maharashtra—Taroba N.P.

No photograph.)

Krishnan : Mammals

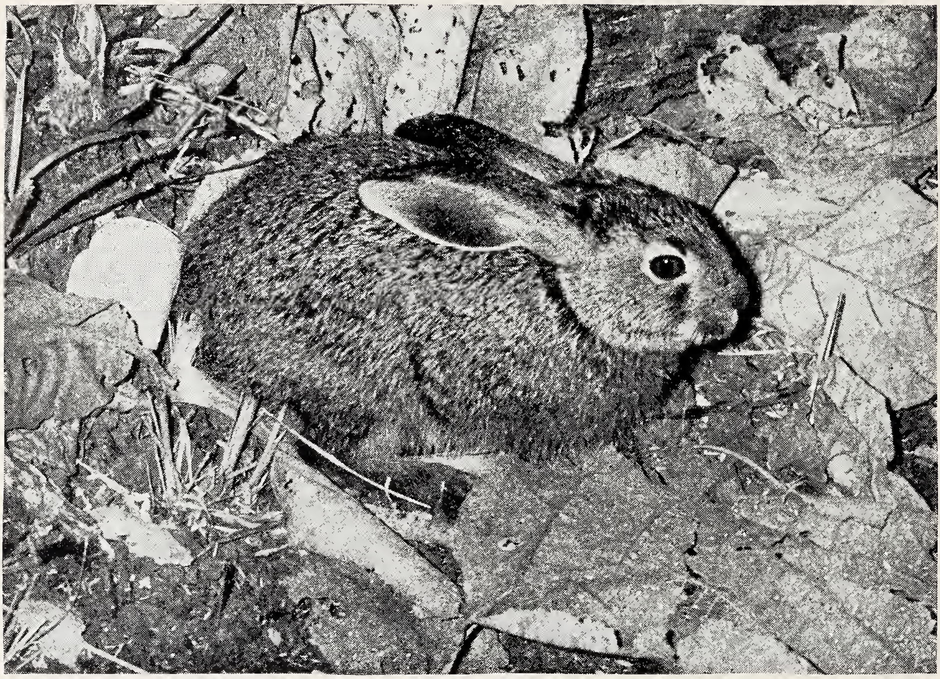


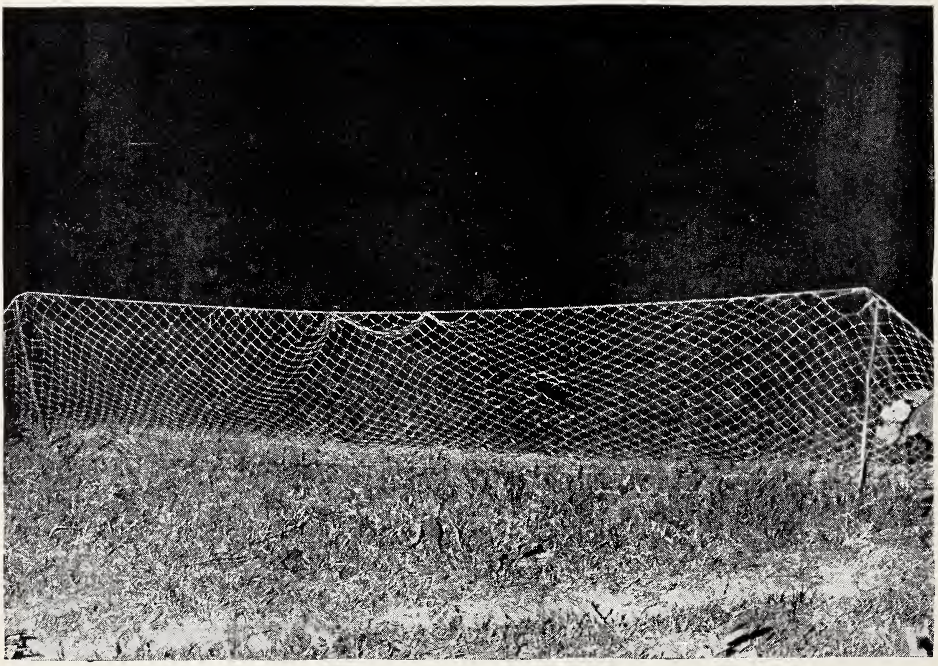


Above : TAMIL NADU 1969 : MUDUMALAI SA. : Kargudi : September 28 — p.m. : The semi-tame giant squirrel near the Range Office — TN. 53 ; *Below :* BIHAR 1969 : BETLA : PALAMAU : February 21 — Night : Hare — B. 14.

(*Photos : M. Krishnan*)

Krishnan : Mammals





Above : M. P. 1969 : BORI : March 21 — midnight : Hare on the road-side — MP. 23 ;
Below : MAHARASHTRA 1968 : TAROBA N. P. : November 18 — about 8.15 p.m. :
Net spread for poaching hares, near Jamni — MR. 3.

(Photos : M. Krishnan)

Size : Morphological characters

This is said to be one of the largest of all porcupines, and the species in which the quills are best developed. A big porcupine may weigh up to 40 lb. and be nearly a yard long. The quills just above the tail are short, stout, white and very sharply pointed—these do the most damage when the porcupine gets home with its reverse-gear charge. The semi-translucent rattling quills on the tail are hollow, open at the top, and shaped like miniature wine-glasses with no bases.

Distribution

In forest areas, all over the peninsula.

Habits : Behaviour

There is a belief, both here and in Africa, that the porcupine occasionally drinks water by sucking the water retained in its hollow tail-quills : this, of course, is untrue, but it is a fact that these rattling quills are found filled with water when the animal has waded through a puddle or shallow pool. Numerous instances are on record of leopards and tigers (both very fond of porcupine flesh) getting badly stuck by the quills in attacking porcupines, even in attacks by porcupines—there are instances of such misadventures ending fatally for the predator. Dunbar Brander gives an interesting note on the animal.

Porcupines gnaw bones and antlers found in the forest floor, and gardeners in forest-side area know their partiality for the roots and shoots of many plants. They also eat fruit on occasion : a big porcupine was seen with a ripe bael fruit in its mouth (B 68 Apr. 20).

The porcupine is nocturnal and during the day it is said to sleep in deep, subterranean retreats, usually with more than one exit hole. However, it does also lie up in tall grass on occasion (TN 63 Mar. 17).

Apart from the noise made by the rattling of the hollow tail quills, when surprised the porcupine bristles out its body quills at once, with a swishing sound, suddenly growing large and indistinct : its getaway is marked by sharply angled turns, and when it has put some distance between itself and what alarms it, the quills subside suddenly, so that the animal becomes much smaller, darker and harder to see.

THE INDIAN HARE

Lepus nigricollis (Cuvier)

(Summary of field notes : Observation records : around 60.

Locations: Kerala—Periyar Sa.: Tamil Nadu—Mudumalai Sa.: Orissa—Badrama : Bihar—Hazaribagh N.P., Kodarma, Palamau N.P., Karkatnagar, Madhya Pradesh ; Churna, Shivpuri N.P., Bara Naya Para ; Maharashtra—Taroba N.P.

Photographs : B 14, MR 3, MP 23.)

Hares, miscalled rabbits all over India, are fairly common in scrub and open forests in the peninsula.

Size : Morphological characters

The Blacknaped Hare (*L. n. nigricollis*) of the southern areas of the peninsula is larger than the Rufoustailed Hare (*L. n. ruficaudatus*) of the northern areas. 5 to 6 lb. is the weight of an adult.

Distribution

Scrub jungle around villages, open forests where there are clearings, and bush-covered plains form the chief habitats in peninsular India. Hares are commonly seen along forest roads at night.

Habits : Behaviour

Hares are mainly nocturnal. They appear to be dazed by a bright beam of light at night, such as the headlights of a motor car, and in such lighting their normally dark, somewhat protuberant eyes appear blood red, but the glare does not seem to dazzle them entirely. I have watched dozens of attempts to catch a hare crouching in the glare of spotlights and electric torches (and tried to so catch them myself) but have never known one actually caught (TN 59 Mar. 26). However, such glare, in conjunction with jingling sounds, appears to stupefy them sufficiently to be easily clubbed to death. Hare-nets are usually provided with a number of bells along their lower hem, to make them jingle when a hare rushes into them (MR 68 Nov. 18 : photograph MR 3).

During the day, hares crouch in bushes much oftener than in grass, though they may lie up in tall grass, too, where such grass in patches and belts adjoins open ground (TN 64 Sep. 27, MY 69 Oct. 16, K 70 Apr. 29).

Short grasses appear to be the main food. However, other ground plants are also eaten ; in coastal areas, *Ipomoea pes-caprae* is much eaten.

Apparently there is a break in the feeding activity between midnight and 4 a.m., when very few hares are seen in the open : they are to be seen crouching in bush cover then, often moving their jaws, as if reingesting soft-pellets.

Hares were frequently seen, usually singly, along forest roads and alongside them, during night drives. Where close bush cover was available, they crept away through the bush, but where the undershrub was more open, bounded away, sometimes making prodigious leaps.

Men, jungle cats, even leopards, jackals, wild dogs, mongooses and otters (when hunting on land) all prey on hares, and so do the larger owls and even diurnal birds of prey such as the crested hawk-eagle (TN 62 Mar. 18, 70 Sep. 24).

(*to be continued*)

Ixodid Ticks (Acarina: Ixodidae) parasitizing wild birds in the Kyasanur Forest disease area of Shimoga District, Mysore State, India

BY

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(*With a map and two text-figures*)

During a two year study on ticks parasitizing wild birds of Shimoga District, Mysore State, 8474 birds (184 species) were examined and 1082 birds of 81 species were found infested. The genus *Haemaphysalis* accounted for 99·5% of all the ticks collected and the remaining belonged to the genera *Dermacentor*, *Amblyomma*, *Boophilus* and *Hyalomma*. *H. spinigera* was the commonest species of *Haemaphysalis* on birds, closely followed by *H. wellingtoni* and *H. turturis* and nine other species, including a new species *H. megalaimae*. There was no evidence of birds bringing into India, ticks not indigenous to India. The seasonal variations in the infestation by various tick stages and species and the host parasite relationships are also discussed.

INTRODUCTION

During the early part of the investigations on the epidemiology of Kyasanur Forest Disease (KFD), a tick transmitted virus disease affecting men and monkeys in Shimoga District, Mysore State, neutralizing antibodies against KFD virus were found in the sera of several species of wild caught birds [Virus Research Centre (VRC) Annual Report]. Avian involvement in the epidemiology of this disease by their role in the transport of infected ticks, in the maintenance of a tick bird virus cycle and in the dissemination of the virus was suggested by Work (1958). A two-year study on the wild birds of this district was therefore started in December 1959, primarily to study the tick infestation pattern and also incidentally to study the immunity status of these birds against KFD virus. The present communication deals only with the study on the parasitism of birds by ticks.

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[1] The Virus Research Centre was, at the time this study was made, jointly maintained by the Indian Council of Medical Research and the Rockefeller Foundation.

There is a lack of published information on any major study on ticks of Indian birds, although references in the literature on intensive studies on ticks of birds in other parts of the world are many. Since the tick species and avian hosts mentioned in these studies are not indigenous to the KFD area, it will not be relevant to detail them here. In India, Sharif (1928) and Sen (1938) have mentioned the parasitism of the domestic fowl by *Haemaphysalis wellingtoni*. Studies on the ticks of migratory birds in Saurashtra and other parts of North Western India conducted by the Bombay Natural History Society have shown the parasitism of many birds by several tick species. Hoogstraal & Trapido (1963a) have recorded *Haemaphysalis kutchensis* nymphs from a variety of ground feeding birds in Kutch, Gujarat State. Dhanda (1964) had collected nymphs of *H. howletti* from the Crow Pheasant, *Centropus sinensis*. All the stages of *H. centropi* were also collected from the same host species (Dhanda, personal communication). Dhanda & Rao (1964) in their report on tick collections made in North East Frontier Agency of India had reported the presence of nymphs of *Amblyomma testudinarium* and *Haemaphysalis formosensis* on the Red Junglefowl, *Gallus gallus*. Rebello & Reuben (1967) in a recent study examined 590 birds belonging to 55 species in Vellore, Madras State, and had collected ticks from 136 birds belonging to 16 species. The tick species collected were *Haemaphysalis intermedia*, *H. bispinosa*, and *Hyalomma marginatum isaaci*, all of which were taken on birds during the present study.

The study area has been described by several authors in great detail (Trapido *et al.* 1964a; Rajagopalan, *et al.* 1968a and Boshell 1969). It is situated in Shimoga District, between latitudes 13° 30′ and 14° 45′N. and longitudes 74° 30′ and 76° 15′ E. and can be roughly divided into three main zones of heavy, intermediate and low rainfall (Map). Most of the host sample was collected from the intermediate rainfall zone which has an annual rainfall of 1524-2540 mm. per year and comprises the KFD infected areas of Sagar and Sorab taluks. The country is a gently undulating one at an elevation of about 600 metres above sea level and is mostly covered by semi-deciduous rain forest. Most of the rainfall takes place during the four monsoon months from June to September. A vast forest cover with arecanut and banana plantations and paddy fields interspersed with numerous scattered villages is the characteristic feature of this area.

MATERIALS AND METHOD

Collection and identification of birds :

During the early part of the study, birds were obtained by trapping them in nylon mist nets. Since mistnet trapping was not very productive

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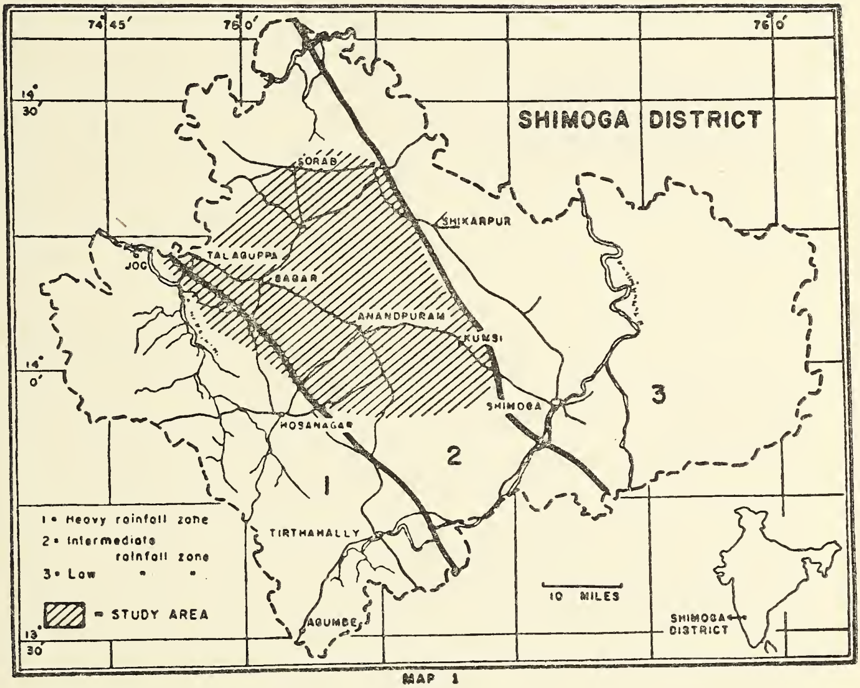

74° 45′
75° 0′
76° 0′
14° 30′
14° 0′
13° 30′
SHIMOGA DISTRICT
SORAB
SHIKARPUR
TALAGUPPA
JOG
SAGAR
ANANDPURAM
KUMSI
SHIMOGA
HOSANAGAR
TIRTHAHALLY
AGUMBE
1
2
3
1 = Heavy rainfall zone
2 = Intermediate rainfall zone
3 = Low " "
▨ = STUDY AREA
10 MILES
SHIMOGA DISTRICT

MAP 1

and since the object was to collect and examine at least 300 birds every month, shooting was resorted to, with a 410 Savage shotgun using no. 9 shots. Each bird, after proper labelling, was individually wrapped in lint and taken to the field laboratory. Identifications of birds were made with the help of descriptions given by Sálim Ali (1942, 1943, 1949, 1953, 1955) and Whistler (1949) which also provided useful information on migratory status and nesting habits of birds. Birds with doubtful or unknown identity were skinned and were later identified by the Bombay Natural History Society. The scientific names of birds used in this paper are those given by Ripley (1961).

Collection and identification of ticks :

Each bird was carefully examined with a magnifying glass and the ticks collected were preserved in 70 per cent alcohol for later identification. Initially, the immature stages of ticks were given arbitrary type numbers. The final identification of ticks was done with the help of a key by Trapido *et al.* (1964b).

RESULTS

The host sample :

During the two-year period December 1959 to November 1961, 8474 birds belonging to 184 species were examined for ticks, of which 416 birds belonging to 25 species were listed as migrants by Ripley (1961). A total of 1082 birds belonging to 81 species had ticks on them. The number of birds examined in different months during the two year period is given in Table 1. The largest number (927) was in November and the smallest number in June (400). The largest number of birds found positive for ticks was also in November (205) and the smallest number in June (28).

Birds which were examined and found negative for ticks are listed below, with the number of each species examined in parenthesis. *Podiceps ruficollis* (2) ; *Phalacrocorax carbo* (2) ; *Ardea cinerea* (1) ; *Ardeola grayii* (120) ; *Bubulcus ibis* (92) ; *Egretta alba* (3) ; *Egretta garzetta* (8) ; *Gorsachius melanolophus* (2) ; *Ixobrychus cinnamomeus* (1) ; *Dendrocygna javanica* (48) ; *Anas crecca* (1) ; *Anas poecilorhyncha* (2) ; *Nettapus coromandelianus* (35) ; *Milvus migrans* (3) ; *Haliastur indus* (5) ; *Accipiter virgatus* (2) ; *Butastur teesa* (1) ; *Aquila rapax* (3) ; *Torgos calvus* (1) ; *Gyps bengalensis* (1) ; *Neophron percnopterus* (4) ; *Spilornis cheela* (4) ; *Falco tinnunculus* (4) ; *Turnix tanki* (1) ; *Rallus striatus* (1) ; *Gallinula chloropus* (2) ; *Porphyrio porphyrio* (8) ; *Fulica atra* (7) ; *Hydrophasianus chirurgus* (1) ; *Metopidius indicus* (35) ; *Tringa ochropus* (15) ; *Tringa hypoleucos* (8) ; *Capella gallinago* (3) ; *Ducula aenea* (60) ; *Columba livia* (8) ; *Streptopelia orientalis* (4) ; *Streptopelia chinensis*

(261) ; *Psittacula cyanocephala* (58) ; *Clamator jacobinus* (12) ; *Cacomantis merulinus* (1) ; *Surniculus lugubris* (2) ; *Athene brama* (4) ; *Caprimulgus indicus* (2) ; *Hemiprocne longipennis* (11) ; *Harpactes fasciatus* (14) ; *Alcedo atthis* (9) ; *Pelargopsis capensis* (9) ; *Halcyon smyrnensis* (22) ; *Merops leschenaulti* (32) ; *Merops philippinus* (1) ; *Merops orientalis* (71) ; *Nyctyornis athertoni* (4) ; *Anthracoceros coronatus* (3) ; *Megalaima zeylanica* (5) ; *Jynx torquilla* (1) ; *Picumnus innominatus* (2) ; *Micropternus brachyurus* (16) ; *Picus chlorolophus* (15) ; *Dendrocopos mahrattensis* (6) ; *Dendrocopos nanus* (11) ; *Hirundo rustica* (10) ; *Hirundo smithii* (18) ; *Hirundo daurica* (26) ; *Lanius excubitor* (14) ; *Oriolus chinensis* (1) ; *Artamus fuscus* (34) ; *Dendrocitta leucogastra* (14) ; *Corvus splendens* (8) ; *Hemipus picatus* (14) ; *Coracina novaehollandiae* (5) ; *Aegithina tiphia* (91) ; *Pycnonotus priocephalus* (7) ; *Pycnonotus melanicterus* (16) ; *Hypsipetus indicus* (57) ; *Rhopocichla atriceps* (26) ; *Muscicapa pallipes* (5) ; *Muscicapa thalassina* (4) ; *Cuclicicapa ceylonensis* (7) ; *Monarcha azurea* (11) ; *Prinia socialis* (1) ; *Muscicapa latirostris* (4) ; *Muscicapa parva* (3) ; *Orthotomus sutorius* (29) ; *Schoenicola platyura* (2) ; *Acrocephalus agricola* (3) ; *Sylvia curruca* (2) ; *Erithacus svecicus* (1) ; *Erithacus brunneus* (1) ; *Monticola cinclorhynchus* (1) ; *Parus major* (3) ; *Sitta frontalis* (11) ; *Anthus novaeseelandiae*

TABLE 1

SUMMARY OF MONTHLY INFESTATION OF BIRDS BY TICKS DURING THE TWO-YEAR STUDY (December 1959-November 1961)

Months	I Year (Dec. 59-Nov. 60)			II Year (Dec. 60-Nov. 61)			Both years combined		
	Number Examined	No.+ve for ticks	Percentage infestation	Number Examined	No.+ve for ticks	Percentage infestation	Number Examined	No. +ve for ticks	Percentage infestation.
December	520	65	12·5	373	46	12·3	893	111	12·4
January ..	322	46	14·3	353	51	14·4	675	97	14·3
February ..	532	56	10·5	419	69	16·4	951	125	13·1
March ..	323	20	6·3	371	69	18·6	694	89	12·8
April ..	377	27	7·2	330	53	16·0	707	80	11·3
May ..	365	21	5·9	353	35	9·9	718	56	7.7
June ..	256	14	5·4	144	14	9·7	400	28	7·0
July ..	362	23	6·3	175	16	9·0	537	39	7·2
August ..	318	23	7·2	215	20	9·2	533	43	8·0
September ..	280	11	3·9	336	22	6·5	616	33	5·3
October ..	428	89	20·8	395	87	22·0	823	176	21.3
November ..	616	125	20·3	311	80	25·7	927	205	22·1
Total ..	4699	520	11·07	3775	562	14·8	8474	1082	12·7

(1) ; *Motacilla indica* (2) ; *Motacilla alba* (10) ; *Dicaeum agile* (18) ; *Nectarinia zeylonica* (32) ; *Nectarinia asiatica* (17) ; *Arachnothera longirostris* (3) ; *Zosterops palpebrosa* (2) ; *Ploceus philippinus* (29) ; *Lonchura malabarica* (1) ; *Lonchura keelarti* (11) ; *Lonchura malacca* (55).

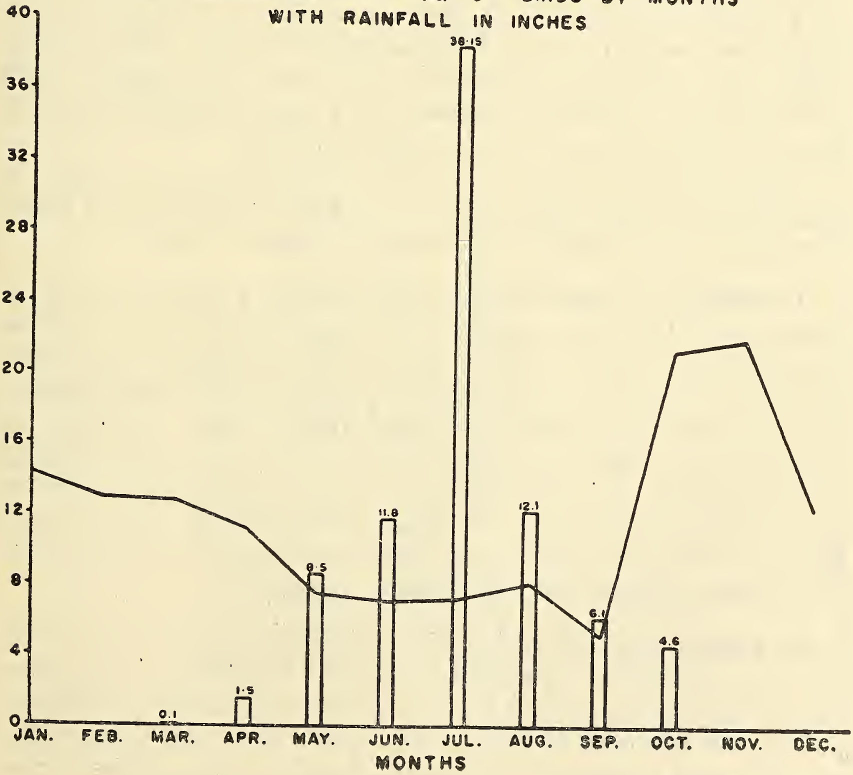
Among the species listed above are those which are aquatic and those which frequent tank bunds, mud flats and irrigated fields. Many arboreal and terrestrial species have also been found negative for ticks, though sizable numbers of them were examined at a time of the year when most of the other bird species were found infested with ticks.

Birds of the family Phasianidae had the highest rate of infestation (87·5%). The other families of birds showing high tick infestation rates were Cuculidae (Crow Pheasant), Muscicapidae (Babblers, Thrush etc.), Sturnidae (Mynas) and Motacillidae (Wagtails). Birds of these families are either ground living or ground frequenting.

The highest rate of infestation as well as the largest number of birds found positive for ticks in any month are in November (Fig. 1) and this month along with October corresponds with the season of predominance of tick larvae on the forest floor. During the monsoon months from

FIG. 1

TICK INFESTATION RATE (%) OF BIRDS BY MONTHS WITH RAINFALL IN INCHES



June to September the tick infestation rate in birds is very low and this season corresponds with the predominance of adult ticks in the forest and the almost complete inactivity and scarcity of immature tick stages.

The tick sample :

The ticks collected from birds during the two year study were of six genera in the family Ixodidae. Though two species of *Ixodes*, namely *I. petauristae* and *I. ceylonensis* are common in the study area, no *Ixodes* was found on any bird.

In all, 9821 ticks belonging to six genera and 17 species were collected (Table 2). More than 99 per cent of all the ticks collected (9774) belonged to the genus *Haemaphysalis* and comprised 12 of the 14 species of this genus recorded in the study area. The two species not found on birds were *H. cornigera shimoga* and *H. canastrini* group (formerly *H. leachi*). The remaining 47 ticks (0·5 per cent of the total) belonged to the genera *Dermacentor*, *Rhipicephalus*, *Amblyomma*, *Boophilus* and *Hyalomma*.

The most dominant species of *Haemaphysalis* collected on birds was *spinigera*, which formed 74·1 per cent of all ticks belonging to this genus. The other species, in order of their abundance, were *H. wellingtoni* (10·9%), *H. turturis* (6·2%), *H. bispinosa* (3·9%), *H. intermedia* (1·6%), *H. papuana kinneari* (1·5%), *H. kyasanurensis* (0·6%), and *H. minuta* (0·4%). *H. megalaimae* was found only on one host species. Small numbers of *H. cuspidata*, *H. aculeata* and a single specimen of *H. centropi* were also collected on birds during this study.

The various bird species found positive for ticks and the number of different stages of each species collected on birds are presented on Tables 3 and 4, and the individual tick species are discussed below.

H. spinigera is commonest of all ticks found in ground drags and on vegetation in the study area and has been collected from 715 birds belonging to 69 species. Thirty-two per cent of all *spinigera* was taken on the Crow Pheasant, *Centropus sinensis* and 33% on the Jungle Babbler, *Turdoides striatus*. *Acridotheres fuscus*, Jungle Myna, accounted for 12% and the Jungle fowl, *Gallus sonneratii* for 9%. The remaining 14% were found on 65 species of birds. Larvae were found on 35 species and nymphs on 42 species. Of the six adults collected, five were from *Gallus sonneratii* and one from *Acridotheres fuscus*. All the adults were teneral and apparently not feeding on the hosts.

H. wellingtoni is a recognized bird ectoparasite but was not encountered in large numbers in ground drags or on vegetation. The number and variety of birds infested by this tick were second only to *spinigera* as 292 birds belonging to 39 species were positive for this tick. Eighty per cent of all *wellingtoni* was collected from three host species, *Gallus*

TABLE 2

NUMBER OF TICKS COLLECTED ON BIRDS, BY SPECIES AND STAGES, WITH THE NUMBER OF HOSTS POSITIVE FOR EACH SPECIES

	Number of host species positive	Number of birds positive	Larvae	No. of ticks Nymphs	Collected Adults	Total
1. *Haemaphysalis spinigera* Neumann, 1897 ..	69	715	6119	1119	6	7244
2. *Haemaphysalis wellingtoni* Nuttall and Warburton, 1907 ..	39	292	672	253	148	1073
3. *Haemaphysalis turturis* Nuttall and Warburton, 1915	24	144	332	267	10	609
4. *Haemaphysalis bispinosa* Neumann, 1897 ..	24	113	303	84	2	389
5. *Haemaphysalis intermedia* Warburton and Nuttall, 1909 ..	15	75	116	23	16	155
6. *Haemaphysalis papuana kinneari* Warburton, 1913	15	41	119	17	0	136
7. *Haemaphysalis kyasanurensis* Trapido, Hoogstraal and Rajagopalan, 1964 ..	11	22	27	28	0	55
8. *Haemaphysalis minuta* Kohls, 1950 ..	6	24	3	24	12	39
9. *Haemaphysalis megalaimae* Rajagopalan, 1963 ..	1	13	1	16	27	44
10. *Haemaphysalis aculeata* Lavarra, 1905 ..	6	11	4	12	0	16
11. *Haemaphysalis cuspidata* Warburton, 1910 ..	4	9	6	6	1	13
12. *Haemaphysalis centropi* Kohls, 1949 ..	1	1	0	0	1	1
All *Haemaphysalis* ticks ..			7702	1849	223	9774
13. *Dermacentor auratus* Supino, 1897 ..			16	0	0	16
14. *Rhipicephalus* sp. ..			15	1	0	16
15. *Amblyomma* sp. ..			5	8	0	13
16. *Boophilus* sp. ..			1	0	0	1
17. *Hyalomma marginatum isaaci* Sharif, 1928 ..			0	1	0	1
			37	10	0	47
Grand Total :			7739	1859	223	9821

Table

Haemaphysalis ticks collected from different

L : Larvae, N : Nymphs,

Species of Birds found positive for ticks	*No. birds +/ No. examined*	*spinigera* L/N/Ad	*wellingtoni* L/N/Ad	*turturis* L/N/Ad
1	2	3	4	5
1. *Accipiter badius*	5/32	0/6/0	0/1/0	—
2. *Circaetus gallicus*	1/1	0/1/0	0/0/1	—
3. *Galloperdix spadicea*	2/3	0/16/0	1/4/0	0/3/0
4. *Gallus sonneratii*	23/25	450/226/5	122/107/44	102/161/7
5. *Pavo cristatus*	1/1	—	12/15/0	0/2/0
6. *Amaurornis phoenicurus*	1/6	—	2/0/0	—
7. *Vanellus indicus*	1/21	—	—	—
8. *Vanellus malabaricus*	1/24	—	1/0/0	—
9. *Charadrius dubius*	2/15	1/1/0	—	—
10. *Treron pompadora*	1/109	1/1/0	—	—
11. *Treron phoenicoptera*	1/63	0/1/0	—	—
12. *Chalcophaps indica*	1/17	—	—	—
13. *Psittacula columboides*	2/93	0/1/0	—	—
14. *Loriculus vernalis*	2/61	1/0/0	—	0/1/0
15. *Centropus sinensis*	129/151	2194/202/0	226/57/92	120/47/2
16. *Eudynamis scolopacea*	2/74	—	1/1/0	—
17. *Rhopodytes viridirostris*	2/31	3/0/0	—	—
18. *Coracias benghalensis*	2/23	—	—	—
19. *Upupa epops*	2/10	2/0/0	—	—
20. *Tockus griseus*	6/80	1/0/0	0/0/2	2/0/0
21. *Megalaima viridis*	15/297	1/1/0	—	—
22. *Megalaima rubricapilla*	2/152	2/0/0	—	—
23. *Dinopium benghalense*	12/162	8/2/0	—	1/2/0
24. *Drycopus javensis*	2/14	1/0/0	—	—
25. *Hemicircus canente*	1/48	1/0/0	—	—
26. *Pitta brachyura*	5/13	25/8/0	—	—
27. *Mirafra erythroptera*	3/16	1/0/0	1/0/0	1/0/0
28. *Galeridia malabarica*	7/108	2/0/0	3/0/0	—
29. *Alauda gulgula*	3/59	—	1/0/0	—
30. *Lanius vittatus*	1/10	1/0/0	—	—
31. *Lanius schach*	6/29	21/0/0	—	2/0/0
32. *Lanius cristatus*	1/6	40/0/0	—	—
33. *Oriolus oriolus*	3/78	4/0/0	—	—
34. *Oriolus xanthornus*	1/28	1/0/0	—	—
35. *Dicrurus adsimilis*	14/146	22/4/0	—	—
36. *Dicrurus leucophaeus*	1/80	1/0/0	—	—
37. *Dicrurus caerulescens*	4/20	7/0/0	12/0/0	—
38. *Dicrurus hottentottus*	1/2	2/0/0	—	—
39. *Dicrurus paradiseus*	3/49	4/0/0	1/0/0	0/1/0
40. *Sturnus malabaricus*	3/107	3/1/0	—	—
41. *Sturnus pagodarum*	10/95	1/0/0	1/2/0	3/0/0
42. *Sturnus roseus*	4/128	1/1/0	0/1/0	—
43. *Acridotheres tristis*	61/416	108/10/0	20/4/1	4/9/0
44. *Acridotheres fuscus*	159/787	773/95/1	25/11/0	15/8/0
45. *Gracula religiosa*	3/246	0/3/0	—	—
46. *Corvus macrorhynchos*	4/30	6/3/0	1/0/0	—

3

BIRDS, BY SPECIES AND STAGES

AD : ADULTS

bispinosa L/N/Ad	*intermedia* L/N/Ad	*papuana kinneari* L/N	*kyasanurensis* L/N	*minuta* L/N/Ad	*megalaimae* L/N/Ad	*aculeata* L/N	*cuspidata* L/N/Ad	*centropi* Ad
6	7	8	9	10	11	12	13	14
4/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
30/14/1	2/1/0	32/5/0	9/10	2/8/12	—	2/4	0/1/0	—
63/19/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
0/ 1/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	1/0/0	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
116/36/0	37/5/15	7/6/0	1/2	0/2/0	—	0/6	5/4/1	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/1/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	0/1/0	—	—	—	—	0/1/0	—
—	—	1/0/0	—	—	1/16/27	—	—	—
—	—	—	—	—	—	—	—	—
—	1/0/0	—	—	—	—	—	—	—
—	—	0/1/0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
0/1/0	—	—	—	—	—	—	—	—
0/1/0	3/0/0	—	—	—	—	—	—	—
1/1/0	—	—	—	—	—	—	—	—
—	—	1/0/0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	2/0	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2/0/0	—	—	—	0/1/0	—	—	—	—
7/0/0	2/0/0	—	—	—	—	—	—	—
—	—	—	—	0/1/0	—	—	—	—
11/2/1	3/0/0	—	—	—	—	—	—	1
11/2/0	27/0/0	2/0/0	6/1	0/2/0	—	0/1	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—

TABLE 3

Haemaphysalis TICKS COLLECTED FROM DIFFERENT BIRDS, BY SPECIES AND STAGES

L : LARVAE, N : NYMPHS, AD : ADULTS

Species of Birds found positive for ticks	No. birds +/ No. examined	*spinigera* L/N/Ad	*wellingtoni* L/N/Ad	*turturis* L/N/Ad	*bispinosa* L/N/Ad	*intermedia* L/N/Ad	*papuana kinneari* L/N	*kyasanurensis* L/N	*minuta* L/N/Ad	*megalaimae* L/N/Ad	*aculeata* L/N	*cuspidata* L/N/Ad	*centropi* Ad
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. *Accipiter badius*	5/32	0/6/0	0/1/0	—	4/0/0	—	—	—	—	—	—	—	—
2. *Circaetus gallicus*	1/1	0/1/0	0/0/1	—	—	—	—	—	—	—	—	—	—
3. *Galloperdix spadicea*	2/3	0/16/0	1/4/0	0/3/0	—	—	—	—	—	—	—	—	—
4. *Gallus sonneratii*	23/25	450/226/5	122/107/44	102/161/7	30/14/1	2/1/0	32/5/0	9/10	2/8/12	—	2/4	0/1/0	—
5. *Pavo cristatus*	1/1	—	12/15/0	0/2/0	63/19/0	—	—	—	—	—	—	—	—
6. *Amaurornis phoenicurus*	1/6	—	2/0/0	—	—	—	—	—	—	—	—	—	—
7. *Vanellus indicus*	1/21	—	—	—	0/ 1/0	—	—	—	—	—	—	—	—
8. *Vanellus malabaricus*	1/24	—	1/0/0	—	—	—	—	—	—	—	—	—	—
9. *Charadrius dubius*	2/15	1/1/0	—	—	—	—	—	—	—	—	—	—	—
10. *Treron pompadora*	1/109	1/1/0	—	—	—	—	—	—	—	—	—	—	—
11. *Treron phoenicoptera*	1/63	0/1/0	—	—	—	—	—	—	—	—	—	—	—
12. *Chalcophaps indica*	1/17	—	—	—	—	1/0/0	—	—	—	—	—	—	—
13. *Psittacula columboides*	2/93	0/1/0	—	—	1/0/0	—	—	—	—	—	—	—	—
14. *Loriculus vernalis*	2/61	1/0/0	—	0/1/0	—	—	—	—	—	—	—	—	—
15. *Centropus sinensis*	129/151	2194/202/0	226/57/92	120/47/2	116/36/0	37/5/15	7/6/0	1/2	0/2/0	—	0/6	5/4/1	—
16. *Eudynamis scolopacea*	2/74	—	1/1/0	—	—	—	—	—	—	—	—	—	—
17. *Rhopodytes viridirostris*	2/31	3/0/0	—	—	—	—	—	—	—	—	—	—	—
18. *Coracias benghalensis*	2/23	—	—	—	1/1/0	—	—	—	—	—	—	—	—
19. *Upupa epops*	2/10	2/0/0	—	—	—	—	—	—	—	—	—	—	—
20. *Tockus griseus*	6/80	1/0/0	0/0/2	2/0/0	—	—	0/1/0	—	—	—	—	0/1/0	—
21. *Megalaima viridis*	15/297	1/1/0	—	—	—	—	1/0/0	—	—	1/16/27	—	—	—
22. *Megalaima rubricapilla*	2/152	2/0/0	—	—	—	—	—	—	—	—	—	—	—
23. *Dinopium benghalense*	12/162	8/2/0	—	1/2/0	—	1/0/0	—	—	—	—	—	—	—
24. *Drycopus javensis*	2/14	1/0/0	—	—	—	—	0/1/0	—	—	—	—	—	—
25. *Hemicircus canente*	1/48	1/0/0	—	—	—	—	—	—	—	—	—	—	—
26. *Pitta brachyura*	5/13	25/8/0	—	—	—	—	—	—	—	—	—	—	—
27. *Mirafra erythroptera*	3/16	1/0/0	1/0/0	1/0/0	0/1/0	—	—	—	—	—	—	—	—
28. *Galeridia malabarica*	7/108	2/0/0	3/0/0	—	0/1/0	3/0/0	—	—	—	—	—	—	—
29. *Alauda gulgula*	3/59	—	1/0/0	—	1/1/0	—	—	—	—	—	—	—	—
30. *Lanius vittatus*	1/10	1/0/0	—	—	—	—	1/0/0	—	—	—	—	—	—
31. *Lanius schach*	6/29	21/0/0	—	2/0/0	—	—	—	—	—	—	—	—	—
32. *Lanius cristatus*	1/6	40/0/0	—	—	—	—	—	2/0	—	—	—	—	—
33. *Oriolus oriolus*	3/78	4/0/0	—	—	1/0/0	—	—	—	—	—	—	—	—
34. *Oriolus xanthornus*	1/28	1/0/0	—	—	—	—	—	—	—	—	—	—	—
35. *Dicrurus adsimilis*	14/146	22/4/0	—	—	—	—	—	—	—	—	—	—	—
36. *Dicrurus leucophaeus*	1/80	1/0/0	—	—	—	—	—	—	—	—	—	—	—
37. *Dicrurus caerulescens*	4/20	7/0/0	12/0/0	—	—	—	—	—	—	—	—	—	—
38. *Dicrurus hottentottus*	1/2	2/0/0	—	—	—	—	—	—	—	—	—	—	—
39. *Dicrurus paradiseus*	3/49	4/0/0	1/0/0	0/1/0	—	—	—	—	—	—	—	—	—
40. *Sturnus malabaricus*	3/107	3/1/0	—	—	2/0/0	—	—	—	0/1/0	—	—	—	—
41. *Sturnus pagodarum*	10/95	1/0/0	1/2/0	3/0/0	7/0/0	2/0/0	—	—	—	—	—	—	—
42. *Sturnus roseus*	4/128	1/1/0	0/1/0	—	—	—	—	—	0/1/0	—	—	—	—
43. *Acridotheres tristis*	61/416	108/10/0	20/4/1	4/9/0	11/2/1	3/0/0	—	—	—	—	—	—	1
44. *Acridotheres fuscus*	159/787	773/95/1	25/11/0	15/8/0	11/2/0	27/0/0	2/0/0	6/1	0/2/0	—	0/1	—	—
45. *Gracula religiosa*	3/246	0/3/0	—	—	—	—	—	—	—	—	—	—	—
46. *Corvus macrorhynchos*	4/30	6/3/0	1/0/0	—	—	—	—	—	—	—	—	—	—

Table

Haemaphysalis ticks collected from different

L: Larvae, N: Nymphs,

Species of Birds found positive for ticks		*No. birds + / No. examined*	*spinigera* L/N/Ad	*wellingtoni* L/N/Ad	*turturis* L/N/Ad
1		2	3	4	5
47.	*Tephrodornis virgatus* ..	4/105	4/0/0	1/1/0	—
48.	*Tephrodornis pondicerianus* ..	6/84	5/1/0	—	—
49.	*Coracina melanoptera* ..	5/69	3/2/0	2/0/0	—
50.	*Pericrocotus flammeus* ..	2/193	1/0/0	0/0/ 1	—
51.	*Percrocotus cinnamomeus* ..	2/37	2/0/0	—	—
52.	*Chloropsis aurifrons* ..	1/35	0/1/0	—	—
53.	*Chloropsis cochinchinensis* ..	2/47	1/1/0	—	—
54.	*Irena puella* ..	3/62	2/1/0	—	1/0/0
55.	*Pycnonotus jocosus* ..	22/463	23/5/0	1/0/0	—
56.	*Pycnonotus cafer* ..	4/109	4/0/0	2/0/0	—
57.	*Pycnonotus luteolus* ..	1/42	0/1/0	—	—
58.	*Pellorneum ruficeps* ..	12/32	4/15/0	0/2/0	—
59.	*Pomatorhinus schisticeps* ..	3/29	1/0/0	1/0/0	—
60.	*Turdoides subrufus* ..	7/16	0/4/0	—	2/0/0
61.	*Turdoides striatus* ..	267/447	2024/363/0	130/26/0	66/21/0
62.	*Turdoides affinis* ..	53/75	124/34/0	23/5/0	0/1/0
63.	*Muscicapa tickelliae* ..	1/41	0/1/0	—	—
64.	*Rhipidura albogularis* ..	1/1	3/1/0	—	1/0/0
65.	*Terpsiphone paradisi* ..	1/1	0/1/0	—	—
66.	*Prinia sylvatica* ..	2/7	4/0/0	0/1/0	—
67.	*Acrocephalus stentoreus* ..	1/1	—	0/1/0	—
68.	*Acrocephalus dumetorum* ..	14/83	17/5/0	0/1/0	—
69.	*Copsychus saularis* ..	86/332	117/69/0	19/6/1	6/7/0
70.	*Copsychus malabaricus* ..	5/67	3/1/0	0/1/0	0/1/0
71.	*Saxicola caprata* ..	2/20	—	0/2/0	—
72.	*Saxicoloides fulicata* ..	2/7	0/1/0	0/1/0	—
73.	*Zoothera citrina* ..	26/68	56/18/0	13/2/5	2/2/1
74.	*Zoothera dauma* ..	1/10	0/1/0	—	1/0/0
75.	*Turdus merula* ..	9/45	16/7/0	3/1/1	0/1/0
76.	*Parus xanthogenys* ..	1/50	1/0/0	—	—
77.	*Motacilla caspica* ..	11/97	12/1/0	—	3/0/0
78.	*Motacilla maderaspatensis* ..	5/40	2/3/0	—	—
79.	*Passer domesticus* ..	1/17	—	—	—
80.	*Petronia xanthocollis* ..	2/41	—	7/0/0	—
81.	*Lonchura striata* ..	1/33	2/0/0	—	—
			6120/1120/6	632/253/148	332/267/10

sonneratii, *Centropus sinensis* and *Turdoides striatus*. Nearly two-thirds of all adults taken on birds belong to *wellingtoni* and was taken on nine host species.

H. turturis all stages have been taken in the study area in ground drags and on vegetation in numbers second only to *H. spinigera*. This

3

BIRDS, BY SPECIES AND STAGES—(*Contd.*)

Ad : Adults

bispinosa	*intermedia*	*papuana kinnear*	*kyasanurensis*	*ninuta*	*megalaimae*	*aculeata*	*cuspidata*	*centropi*
L/N/Ad	L/N/Ad	L/N	L/N	L/N/Ad	L/N/Ad	L/N	L/N/Ad	Ad
6	7	8	9	10	11	12	13	14
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	0/ 1/ 0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	0/1	—	—	1/0	—	—
—	—	1/0/0	—	—	—	—	—	—
1/0/0	—	3/0/0	0/8	—	—	—	—	—
38/4/0	24/4/0	26/2/0	4/5	1/5/0	—	1/0	—	—
3/0/0	6/6/0	—	0/1	0/1/0	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	2/1/0	2/0	—	—	—	—	—
6/2/0	4/5/0	29/1/0	—	0/2/0	—	—	1/0/0	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
2/0/0	0/1/1	13/0/0	1/0	0/2/0	—	0/1	—	—
—	—	—	—	—	—	—	—	—
—	1/0/0	1/0/0	2/0	—	—	—	—	—
—	—	—	—	—	—	—	—	—
20/0	—	1/0/0	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
1/0/0	—	—	—	—	—	—	—	—
—	5/0/0	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
303/84/2	116/23/16	119/17/0	27/28	3/24/12	1/16/27	4/12	6/6/1	1

tick has been collected from 144 birds belonging to 24 species. Eighty per cent of all *turturis* collected on birds, were from five species of ground frequenting birds, *Gallus sonneratii*, *Centropus sinensis*, *Acridotheres fuscus*, *Turdoides striatus* and *Copsychus saularis*. Though *H. turturis* was originally described from a male collected from a dove, *Turtur suratensis*, in Ceylon, other records of adult hosts are all from mammals.

TABLE 3

Haemaphysalis TICKS COLLECTED FROM DIFFERENT BIRDS, BY SPECIES AND STAGES—(*Contd.*)

L: LARVAE, N: NYMPHS, AD: ADULTS

Species of Birds found positive for ticks	*No. birds + / No. examined*	*spinigera* L/N/Ad	*wellingtoni* L/N/Ad	*turturis* L/N/Ad	*bispinosa* L/N/Ad	*intermedia* L/N/Ad	*papuana kinnear* L/N	*kyasanurensis* L/N	*minuta* L/N/Ad	*megalaimae* L/N/Ad	*aculeata* L/N	*cuspidata* L/N/Ad	*centropi* Ad
1	2	3	4	5	6	7	8	9	10	11	12	13	14
47. *Tephrodornis virgatus* ..	4/105	4/0/0	1/1/0	—	—	—	—	—	—	—	—	—	—
48. *Tephrodornis pondicerianus* ..	6/84	5/1/0	—	—	—	—	—	—	—	—	—	—	—
49. *Coracina melanoptera* ..	5/69	3/2/0	2/0/0	—	—	—	—	—	—	—	—	—	—
50. *Pericrocotus flammeus* ..	2/193	1/0/0	0/0/ 1	—	—	—	—	—	—	—	—	—	—
51. *Percrocotus cinnamomeus* ..	2/37	2/0/0	—	—	—	—	—	—	—	—	—	—	—
52. *Chloropsis aurifrons* ..	1/35	0/1/0	—	—	—	0/ 1/ 0	—	—	—	—	—	—	—
53. *Chloropsis cochinchinensis* ..	2/47	1/1/0	—	—	—	—	—	—	—	—	—	—	—
54. *Irena puella* ..	3/62	2/1/0	—	1/0/0	1/0/0	—	—	—	—	—	—	—	—
55. *Pycnonotus jocosus* ..	22/463	23/5/0	1/0/0	—	—	—	—	—	—	—	—	—	—
56. *Pycnonotus cafer* ..	4/109	4/0/0	2/0/0	—	—	—	—	—	—	—	—	—	—
57. *Pycnonotus luteolus* ..	1/42	0/1/0	—	—	—	—	—	0/1	—	—	1/0	—	—
58. *Pellorneum ruficeps* ..	12/32	4/15/0	0/2/0	—	—	—	1/0/0	—	—	—	—	—	—
59. *Pomatorhinus schisticeps* ..	3/29	1/0/0	1/0/0	—	1/0/0	—	3/0/0	0/8	—	—	—	—	—
60. *Turdoides subrufus* ..	7/16	0/4/0	—	2/0/0	38/4/0	24/4/0	26/2/0	4/5	1/5/0	—	1/0	—	—
61. *Turdoides striatus* ..	267/447	2024/363/0	130/26/0	66/21/0	3/0/0	6/6/0	—	0/1	0/1/0	—	—	—	—
62. *Turdoides affinis* ..	53/75	124/34/0	23/5/0	0/1/0	—	—	—	—	—	—	—	—	—
63. *Muscicapa tickelliae* ..	1/41	0/1/0	—	—	—	—	—	—	—	—	—	—	—
64. *Rhipidura albogularis* ..	1/1	3/1/0	—	1/0/0	—	—	—	—	—	—	—	—	—
65. *Terpsiphone paradisi* ..	1/1	0/1/0	—	—	—	—	—	—	—	—	—	—	—
66. *Prinia sylvatica* ..	2/7	4/0/0	0/1/0	—	—	—	—	—	—	—	—	—	—
67. *Acrocephalus stentoreus* ..	1/1	—	0/1/0	—	1/0/0	—	2/1/0	2/0	—	—	—	—	—
68. *Acrocephalus dumetorum* ..	14/83	17/5/0	0/1/0	—	6/2/0	4/5/0	29/1/0	—	0/2/0	—	—	1/0/0	—
69. *Copsychus saularis* ..	86/332	117/69/0	19/6/1	6/7/0	—	—	—	—	—	—	—	—	—
70. *Copsychus malabaricus* ..	5/67	3/1/0	0/1/0	0/1/0	—	—	—	—	—	—	—	—	—
71. *Saxicola caprata* ..	2/20	—	0/2/0	—	—	—	—	—	—	—	—	—	—
72. *Saxicoloides fulicata* ..	2/7	0/1/0	0/1/0	—	2/0/0	0/1/1	13/0/0	1/0	0/2/0	—	0/1	—	—
73. *Zoothera citrina* ..	26/68	56/18/0	13/2/5	2/2/1	—	—	—	—	—	—	—	—	—
74. *Zoothera dauma* ..	1/10	0/1/0	—	1/0/0	—	1/0/0	1/0/0	2/0	—	—	—	—	—
75. *Turdus merula* ..	9/45	16/7/0	3/1/1	0/1/0	—	—	—	—	—	—	—	—	—
76. *Parus xanthogenys* ..	1/50	1/0/0	—	—	20/0	—	1/0/0	—	—	—	—	—	—
77. *Motacilla caspica* ..	11/97	12/1/0	—	3/0/0	—	—	—	—	—	—	—	—	—
78. *Motacilla maderaspatensis* ..	5/40	2/3/0	—	—	1/0/0	—	—	—	—	—	—	—	—
79. *Passer domesticus* ..	1/17	—	—	—	—	5/0/0	—	—	—	—	—	—	—
80. *Petronia xanthocollis* ..	2/41	—	7/0/0	—	—	—	—	—	—	—	—	—	—
81. *Lonchura striata* ..	1/33	2/0/0	—	—	—	—	—	—	—	—	—	—	—
		6120/1120/6	632/253/148	332/267/10	303/84/2	116/23/16	119/17/0	27/28	3/24/12	1/16/27	4/12	6/6/1	1

sonneratii, *Centropus sinensis* and *Turdoides striatus*. Nearly two-thirds of all adults taken on birds belong to *wellingtoni* and was taken on nine host species.

H. turturis all stages have been taken in the study area in ground drags and on vegetation in numbers second only to *H. spinigera*. This tick has been collected from 144 birds belonging to 24 species. Eighty per cent of all *turturis* collected on birds, were from five species of ground frequenting birds, *Gallus sonneratii*, *Centropus sinensis*, *Acridotheres fuscus*, *Turdoides striatus* and *Copsychus saularis*. Though *H. turturis* was originally described from a male collected from a dove, *Turtur suratensis*, in Ceylon, other records of adult hosts are all from mammals.

In KFD area also, this species was found to be a wild mammal tick in adult stages (Rajagopalan *et al.* 1968b). The ten adults taken in this study were all teneral and not actually attached on the hosts.

H. bispinosa is primarily an ectoparasite of cattle and the immature stages have been taken in small numbers in ground drags and a few adults have also been collected from vegetation. In all, 113 birds belonging to 24 species were found infested with this species. More than 80 per cent of all *bispinosa* was collected from four species of birds, *Pavo cristatus, Gallus sonneratii, Centropus sinensis* and *Turdoides striatus.*

H. intermedia was formerly referred as *H. parva* in literature (Hoogstraal & Trapido 1963b). Though Sharif (1928) mentions that this species ' usually attacks wild animals and consequently of no economic importance ', the adults of this species are common ectoparasites, principally of sheep and goats but also of cattle in the relatively dry open country ' maidan ' in India. This tick is not usually encountered in ground drags in the study area, though 75 birds belonging to 15 species were found infested with various stages of this species of tick. More than a third of all *intermedia* taken were from the Crow Pheasant, *Centropus sinensis.* This host species also accounts for 15 of the 16 adults of *intermedia* in the sample. *H. intermedia* number the third largest among all *Haemaphysalis* adults on birds, in this study, after the common bird tick *H. wellingtoni* and the host specific *H. megalaimae.*

H. papuana kinneari is one of the common species found on ground drags and forest vegetation in KFD area, next in abundance only to *H. spinigera* and *H. turturis.* Adults are primarily parasitic on wild large mammals like the wild boar, *Sus scrofa.* In this study 136 larvae and nymphs of this species were taken on 41 birds of 15 species and nearly 90% of the ticks were collected from five species of ground frequenting birds.

H. kyasanurensis is a species with apparently restricted distribution in the western parts of India and belongs to *H. formosensis* group (Trapido *et al.* 1964c). It is fairly common in the study area, the adults of which chiefly parasitizing wild animals like *Hystrix indica, Canis aureus* etc. Larvae and nymphs of this species have been taken on 22 birds belonging to five species. It is one of the less common species of *Haemaphysalis* parasitizing birds in KFD area.

H. minuta was first described by Kohls (1950) from males collected off jungle fowls in Ceylon. Nymphs and adults of this species have been taken in small numbers from ground drags and vegetation in the study area. In the present study 24 birds belonging to nine species were found infested and 22 of the 39 ticks collected were from the jungle fowl, *Gallus sonneratii*. All the 12 adults collected were also from the jungle fowl which appears to be the preferred host of this tick.

H. megalaimae, a rare tick species, was found parasitizing exclusively the Small Green Barbet, *Megalaima viridis*, and was never obtained from ground drags or on any other host species in the study area. Thirteen birds of this species out of a total of 297 examined were found positive for this tick. This tick belongs to the *centropihoodi* group of bird parasitizing haemaphysalids (Rajagopalan 1963). According to Hume (1890) the barbet nests in tree holes excavating their own holes. They do not always make a fresh nest hole, sometimes taking possession of a hole used the year before. They usually occupy the hole to roost all round the year. This affords a reasonable explanation for the maintenance of the life cycle of *H. megalaimae* either on the bird or in the nest hole. This tick has not been found on any other bird with tree hole nesting habits and hence this appears to be a case of extreme host specificity. Nymphs and adults of this tick were found on the bird in both dry season and monsoon. The single larva collected was in the month of April.

H. aculeata : The nymphs and adults of this species parasitize wild ungulates like spotted deer (*Axis axis*), mouse deer (*Tragulus meminna*) etc. It has been encountered only in very small numbers in ground drags. Sixteen larvae and nymphs were found on eleven birds belonging to six species. It appears that birds are only adventitious hosts for the immature stages of this mammal tick.

H. cuspidata : Like *H. aculeata*, the adults of this species are common ectoparasites of spotted deer and mouse deer in KFD area and all stages have been taken in small numbers in ground drags and on vegetation. Nine birds of four species were positive for this tick, ten of the 13 ticks collected being from the crow pheasant, *Centropus sinensis*.

H. centropi : A rare species in the study area, it has never been collected in ground drags or vegetation. Only one male was collected on a common myna, *Acridotheres tristis*. Originally described from birds of the genus *Centropus*, it was not collected on any of the 151 *Centropus sinensis* examined during this study. This might possibly be a reflection of the geographical limits of parasitism exhibited by the species, as this species has been collected in the drier area about 400 miles north of the study area.

Genera other than Haemaphysalis : The five genera other than the genus *Haemaphysalis* account for less than 0·5% of the total ticks collected in the study area from birds. These and their hosts are listed in Table 4. One interesting record is a nymph of *Hyalomma m. isaaci* from a wagtail, *Motacilla caspica*, a migratory bird.

TABLE 4

NUMBER AND STAGES OF TICKS OTHER THAN *Haemaphysalis* COLLECTED FROM BIRDS

Species of Bird		No. +ve for ticks other than *Haemaphysalis*	No. positive for all ticks	No. of birds examined	*Dermacentor auratus*	*Rhipicephalus* sp.		*Amblyomma* sp.		*Boophilus* sp.	*Hyalomma m. isaaci*	Total number of all stages of ticks.
					L	L	N	L	N	L	N	
1. *Gallus sonneratii*	..	4	23	25	1	1	—	—	3	—	—	5
2. *Centropus sinensis*	..	3	129	151	4	—	—	1	2	—	—	7
3. *Upupa epops*	..	2	2	10	—	2	—	1	—	—	—	3
4. *Tockus griseus*	..	1	6	80	1	—	—	—	—	—	—	1
5. *Lanius schach*	..	1	6	29	—	1	—	—	—	—	—	1
6. *Sturnus pagodarum*	..	1	10	95	1	—	—	—	—	—	—	1
7. *Sturnus roseus*	..	1	4	128	—	—	—	—	1	—	—	1
8. *Acridotheres tristis*	..	1	61	416	1	—	—	—	—	—	—	1
9. *Acridotheres fuscus*	..	7	159	787	3	1	1	1	1	—	—	7
10. *Turdoides striatus*	..	11	267	447	5	9	—	1	1	1	—	17
11. *Turdoides affinis*	..	2	53	75	—	1	—	1	—	—	—	2
12. *Motacilla caspica*	..	1	11	97	—	—	—	—	—	—	1	1
Total	..	35	731	2340	16	15	1	5	8	1	1	47

Seasonal abundance of ticks on birds :

Table 5 presents the number of different species and stages of *Haemaphysalis* ticks collected on birds in different months. October and November are the months when very large numbers of larvae were found on birds (2911 and 2562 respectively). February was the month of nymphal abundance and July was the month when the largest number of adults were collected. This infestation pattern follows the pattern of general abundance of various tick stages in the study area (Rajagopalan *et al.*, loc cit., Fig. 2). It is significant to note that the larvae of *H. spinigera* and *H. turturis*, the two dominant species in ground drags in the study area, have been found on birds in all months of the year, including the monsoon season along with the larvae of *H. wellingtoni*, *H. bispinosa* and *H. intermedia*. For the purpose of analysis of the

TABLE 5

NUMBER OF *Haemaphysalis* TICKS, BY SPECIES AND STAGES, COLLECTED ON BIRDS IN DIFFERENT MONTHS

(Larvae/Nymphs/Adults)

	January	February	March	April	May	June	July	August	September	October	November	December
H. spinigera ..	295/193/1	139/210/2	50/57/1	13/22/0	2/11/0	10/0/0	16/0/0	48/2/0	44/2/0	2782/81/0	2321/356/2	399/185/0
H. wellingtoni ..	79/8/11	177/110/10	99/20/5	47/39/15	42/16/2	5/4/3	45/13/24	46/4/14	3/4/11	35/10/22	119/23/25	35/1/6
H. turturis ..	60/46/0	82/91/5	9/19/3	38/30/2	13/15/0	1/2/0	8/12/0	14/0/0	1/1/0	54/1/0	44/49/0	8/1/0
H. bispinosa ..	30/6/0	96/30/1	74/9/1	6/8/0	8/2/0	2/2/0	15/2/0	5/1/0	24/5/0	11/2/0	29/14/0	3/3/0
H. intermedia ..	1/2/1	8/2/1	6/9/1	14/3/0	17/2/1	21/2/0	30/0/6	3/0/2	1/0/3	7/0/0	4/3/0	4/0/1
H. minuta ..	2/8/1	1/6/3	0/5/0	0/1/0	—	0/0/1	0/0/7	0/1/0	0/1/0	—	0/1/0	0/1/0
H. papuana kinneari ..	30/3/0	21/8/0	0/1/0	1/1/0	0/1/0	—	1/0/0	—	—	15/0/0	38/1/0	13/2/0
H. aculeata ..	2/3/0	0/5/0	—	0/2/0	—	0/1/0	—	—	—	—	—	2/1/0
H. cuspidata ..	0/1/0	1/0/0	0/2/0	5/2/0	0/0/1	—	0/1/0	—	—	—	—	—
H. kyasanurensis	3/2/0	1/21/0	3/0/0	1/1/0	—	—	—	—	—	7/0/0	7/4/0	5/0/0
H. centropi ..		0/0/1	—	—	—	—	—	—	—	—	—	—
H. megalaimae ..		0/8/11	0/0/2	1/1/3	—	0/0/1	0/1/2	—	—	0/0/5	0/6/3	—
Total ..	502/272/14	526/491/34	241/122/13	126/110/20	82/47/4	39/11/5	115/29/39	116/8/16	73/13/14	2911/94/27	2562/457/30	469/194/7

monthly incidence the number of ticks per 10 hosts examined was calculated from the infestation data on four species of ground frequenting birds, namely, *Centropus sinensis*, *Turdoides striatus*, *Turdoides affinis* and *Copsychus saularis*, as only these four hosts species were examined in all months of the year (Table 6). The monthly incidence follows the pattern of general abundance in nature as described above, in the case of *H. spinigera* and *H. turturis*. In the case of *H. wellingtoni*, the larval and nymphal incidence do not appear in a strongly seasonal pattern, as all stages have been found in all months of the year. The adults are probably dropped in niches where the birds live or roost. Since the microecology of such niches remains almost constant throughout the year, the infestation of birds by different stages of *wellingtoni* might be expected to occur in all months of the year.

FIG. 2

PERCENTAGE COLLECTION OF HAEMAPHYSALIS LARVAE AND NYMPHS ON BIRDS BY MONTHS

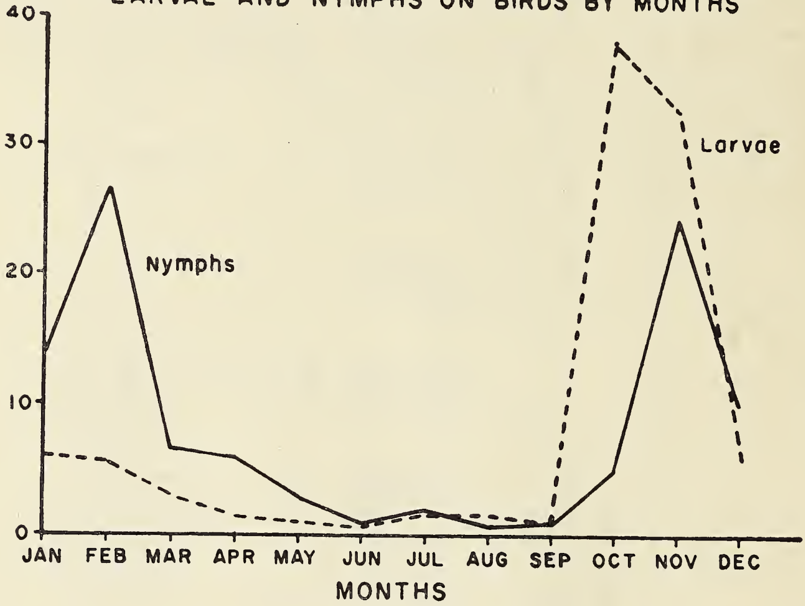


Table 7 presents the frequency distribution of *Haemaphysalis* ticks of all stages on birds. Nearly 39% of the birds positive for larvae had only one larva on each of them, and another 35% had 2-5 larvae on each. Only three birds had more than 200 larvae. The maximum number of larvae (324) was collected from a Jungle Babbler (*Turdoides striatus*) in the month of October. Fifty-seven per cent of the birds positive for nymphs had only one nymph on each of them and only one bird, *Gallus sonneratii* had 118 nymphs in the month of November. The

TABLE 6

MONTHLY INCIDENCE OF THE VARIOUS STAGES OF *H. spinigera*, *H. wellingtoni* AND *H. turturis* ON BUSH BIRDS[1]. DURING THE PERIOD DECEMBER 1959 TO NOVEMBER 1961

Month	No. hosts examined	Number of Ticks per 10 Hosts examined											
		H. spinigera				*H. wellingtoni*				*H. turturis*			
		L	N	A	Tot.	L	N	A	Tot.	L	N	A	Tot.
January ..	68	14·2	18·5	0·0	32·7	6·7	0·7	0·4	7·8	0·7	1·3	0·0	2·0
February ..	93	2·9	14·4	0·0	17·3	5·4	2·0	0·4	7·8	4·7	2·7	0·0	7·4
March ..	83	3·0	4·7	0·0	7·7	7·0	0·8	0·2	8·0	1·7	1·0	0·0	2·7
April ..	121	0·7	1·5	0·0	2·2	3·1	1·4	0·5	5·0	2·8	1·9	0·1	4·8
May ..	110	0·1	0·8	0·0	0·9	2·1	1·2	0·1	3·4	0·2	0·8	0·0	1·0
June ..	61	0·8	0·0	0·0	0·8	0·5	0·5	0·1	1·1	0·2	0·3	0·0	0·5
July ..	92	1·7	0·0	0·0	1·7	4·9	1·3	2·1	8·3	0·7	0·3	0·0	1·0
August ..	93	3·5	0·2	0·0	3·7	4·5	0·2	1·4	6·1	1·3	0·0	0·0	1·3
September ..	48	4·5	0·4	0·0	4·9	0·4	0·4	1·4	2·2	0·0	0·2	0·0	0·2
October ..	93	230·5	6·0	0·0	236·5	1·8	0·5	1·3	3·6	5·1	0·0	0·0	5·1
November ..	77	228·7	20·7	0·0	249·4	7·2	0·9	0·0	8·1	2·7	0·0	0·0	2·7
December ..	61	52·1	19·8	0·0	71·9	4·9	0·1	0·9	5·9	1·3	0·0	0·0	1·3

[1] For the purpose of this table, only four species of hosts were included *Centropus sinensis*, *Turdoides striatus*, *Turdoides affinis* and *Copsychus saularis*. These were the bush frequenting species which have been examined in good numbers in every month of the year.

same host species had the largest number of adults (17) collected in the month of July.

TABLE 7

FREQUENCY DISTRIBUTION OF *Haemaphysalis* TICKS OF ALL STAGES ON BIRDS EXAMINED DURING THE TWO YEAR STUDY, DECEMBER 1959 TO NOVEMBER 1961

Number of ticks	Number of birds in each category					
	with larvae		with nymphs		with adults	
	Frequency	Percentage of birds with larvae	Frequency	Percentage of birds with nymphs	Frequency	Percentage of birds with adults
1	300	38·9	293	57.6	58	58·5
2	137	17·4	78	15·3	17	17·2
3-5	147	18·6	87	17·1	18	18·1
6-10	66	8·3	35	6·9	5	5·1
11-50	110	13·9	13	2·6	1	1·1
51-100	14	1·8	2	0·4	—	—
101-200	13	1·7	1	0·1	—	—
201-300	1	0·4	—	—	—	
301-400	2					
Total	790		509		99	
Maximum no. of ticks on one host	324		118		17	

The frequency of separate and mixed infestations of larvae, nymphs and adults of *Haemaphysalis* ticks of all species is summarized in Table 8. It is found that the birds with only larvae, with both larvae and nymphs and with only nymphs on them, were found in all months of the year. Birds with only larvae were found in much larger numbers during October and November and birds with only nymphs in February. These periods correspond respectively to months of peak larval and nymphal abundance in the forest, as evidenced by dragging operations.

For determining the favoured sites of attachment of ticks on birds only those ticks which were still attached at the time of examination were considered for analysis (Table 9). Most of the ticks were found on the head, neck and throat, vicinity of the beak, eyebrows and ear. A few ticks were also collected from the wings and one nymph from the anus. These ticks were of various species and no evidence was available as to the variation in site preference on the host for the individual tick species. Similar results were obtained by other workers also (Bishopp & Trembley 1945 ; Rosicky & Balat 1954).

TABLE 8

FREQUENCY OF SEPARATE AND MIXED INFESTATIONS OF ALL STAGES OF *Haemaphysalis* TICKS ON BIRDS, BY MONTHS, DURING THE TWO YEAR PERIOD DECEMBER 1959 TO NOVEMBER 1961
(Two years combined)

Month	No. of hosts with: Larvae only	Larvae & Nymphs	Nymphs only	Larvae & Adults	Nymphs & Adults	Larvae, Nymphs and adults	Adults only	No. of ticks collected all species of *Haemaphysalis*: L	N	A	Tot.	No. of hosts positive	No. of hosts examined
December ..	37	44	28	—	—	1		469	194	7	670	110	893
January ..	21	27	42	—	—	6	1	502	272	14	788	97	675
February ..	26	34	54	—	1	8	1	466	492	34	992	124	951
March ..	31	20	29	2	2	4	1	241	122	13	376	89	694
April ..	31	15	21	1	5	2	3	126	110	20	256	78	707
May ..	26	8	16	1	1	2	—	82	47	4	133	54	718
June ..	15	2	6	—	1	—	3	39	11	5	55	27	400
July ..	17	2	4	2	4	1	9	115	29	39	183	39	537
August ..	28	4	1	2	—	1	6	116	8	16	140	42	533
September ..	13	3	5	1	2	—	7	73	13	14	100	31	616
October ..	140	26	3	2	—	1	3	2911	94	27	3032	175	823
November ..	107	64	21	1	2	7	1	2562	457	30	3049	203	927
Total ..	492	249	230	12	18	33	35	7702	1849	223	9774	1069	8474

DISCUSSION

In the present study, involving an examination of 8474 birds belonging to 184 species over a two year period, the immature stages of the commonly occurring species of *Haemaphysalis* in the area were found to parasitize birds. The infestation of birds by ticks depends on factors like the abundance of the ticks in the area, the habits of the host species, and the host preference, or the lack of it, exhibited by the different stages of each tick species. The highest rate of infestation of birds was in the months when larvae of *Haemaphysalis* are abundant. The medium rate of infestation of birds was during the predominant nymphal season from January to March and the lowest rate during the period May to September. In the month of May the low infestation may be due to the fact that larvae are unable to withstand high temperatures. In the monsoon months of June to September, the low infestation may be, firstly, due to the immature stages being either absent in numbers or not very actively questing ; and secondly, because the monsoon period corresponds with the general abundance of adults in the study area, and adults, barring a few species do not readily parasitize birds.

TABLE 9

SITE OF ATTACHMENT OF TICKS ON BODY OF THE HOST

Place where collected	Larvae	Nymphs	Adults	Total	%
1. Top of head	75	18	16	109	23·8
2. Throat and neck	89	36	9	134	29·3
3. Vicinity of beak	65	36	6	107	23·2
4. Wing	25	15	0	40	8·7
5. Eye and eyebrow	22	12	2	36	7·9
6. Ear	7	8	15	30	6·5
7. Anus	0	1	0	1	0·2
Total	283	126	48	457	

The abundance of any particular tick species in the area depends mainly on the availability of adult hosts. Cattle are the chief adult hosts of *H. spinigera* and *H. bispinosa* and to some extent also of *H. turturis*. While the immature stages of *H. spinigera* and *H. turturis* survive and proliferate in the humid environment of the forest, *H. bispinosa* larvae and nymphs seem to survive better in a drier climate or in the open environment of the grass lands. This affords a reasonable explanation for the fact that many birds which are associated with cattle and those frequenting peridomestic situations are found infested with *H. bispinosa*.

With few exceptions, host species infested with ticks are either entirely terrestrial or frequent ground surface in the course of their nesting, roosting or feeding activities. Birds of the family Phasianidae and birds like *Centropus sinensis*, *Turdoides striatus*, *T. affinis*, *Copsychus saularis*, *Acridotheres tristis* and several others come into this category and they are readily parasitized by ticks in the forest. Immature stages of some of the common species of *Haemaphysalis* have been collected by the author from tree trunks at considerable heights. Arboreal birds may thus get infested. Young birds of arboreal species which leave their nest early and are unable to fly well, also spend more time on the ground. These factors may also be responsible for tick infestation of arboreal birds. The roadside birds like Babblers (*Turdoides* sp.), Emerald Dove (*Chalcophaps indica*) and Yellowthroated Sparrow (*Petronia xanthocollis*) get infested by larvae of *H. intermedia*. The immature stages of this tick thrive in situations frequented by sheep and goats, the main adult hosts, which are imported from the drier plains into the study area. The activity of birds also affects tick infestation. Bird activity is reduced during the monsoon. The increased activity of birds in the post-monsoon season also corresponds with the abundance of tick larvae in the forest.

Excepting *H. centropi*, *H. cornigera shimoga* and *H. conastrini* birds in the study area are readily parasitized by the immature stages of most of the *Haemaphysalis* species in the area.

The immature stages of *H. spinigera*, *H. turturis*, *H. bispinosa* and *H. papuana kinneari* readily parasitize birds and mammals, while those of *H. aculeata*, *H. cuspidata* and *H. kyasanurensis* are found only in small numbers on birds. *H. wellingtoni*, a bird tick, has not been taken in the adult stage on mammals. The immature stages of this tick are occasionally found on small mammals and monkeys. Their distribution in the study area appears to be centered around the habitations of their adult hosts, like *Gallus sonneratii*. *H. minuta* also is a main bird ecto-parasite, though immature stages have been taken on man, monkeys and small mammals and on one occasion an adult was also collected on the mongoose, *Herpestes edwardsii*. Thus we find a wide spectrum of host range among the different species of *Haemaphysalis* in the study area, as shown below:

H. megalaimae : All stages exclusively parasitic on one avian host species, *Megalaima viridis*.

H. centropi : All stages exclusively parasitic on birds, chiefly *Centropus* sp., and occasionally others.

H. wellingtoni : All stages chiefly parasitic on birds. Immature stages also attack mammals occasionally.

H. minuta : All stages chiefly parasitic on birds, but also attack mammalian hosts.

H. bispinosa *H. intermedia*	All stages primarily parasitic on mammals (Mainly domestic animal), but also attack birds.
H. aculeata *H. cuspidata* *H. kyasanurensis* *H. p. kinneari* *H. turturis* *H. spinigera*	All stages chiefly parasitic on mammals. The immature stages have a wide host range and attack both birds and mammals. Birds appear to be one of the important sources of blood meal for immature stages. Adults prefer chiefly ungulates and large carnivores.

The number of ticks belonging to genera other than *Haemaphysalis* is so few in the sample, that no specific conclusions could be drawn either about their host pattern or their seasonal abundance. It appears that birds, in the study area, are only adventitious hosts for the immature stages of *Rhipicephalus*, *Amblyomma* and *Boophilus*, which are parasites of large mammals.

Hyalomma marginatum isaaci is a common ectoparasite of livestock and cattle in the drier parts of India and has never been collected in ground drags in the study area. The immature stages of this tick has been taken on several bird species in Rajasthan and Kutch. The finding of a nymph on a migrant wagtail is probably a case of introduction of a tick not indigenous to the area by a migrating bird. This is a two host tick, and it is probable that the nymph of *H. m. isaaci* was picked up as larva by the wagtail in a dry area somewhere along its migratory route. The phenomenon of transportation of ticks by migratory birds from one place to another has important disease spreading potentialities, if the tick thus transported by migratory birds carries pathogens and if the tick is capable of establishing in the area where it was introduced.

The complete absence of *Ixodes petaurustae* and *I. ceylonensis* on any of the large sample of birds examined is noteworthy and indicates that *Ixodes* species of this area do not parasitize birds.

SUMMARY

A two year study on the Ixodid ticks on wild birds of Shimoga District, Mysore State, was undertaken as part of the overall programme of the Virus Research Centre, Poona, on the studies on the epidemiology of Kyasanur Forest Disease. A total of 8474 birds belonging to 184 species was examined over a two year period. Birds of widely differing habits and habitats were collected in every month of a two year period to study the infestation pattern. The number of birds found positive was 1082 belonging to 81 species. A total of 9821 ticks was collected on birds and 99·5% or 9774 ticks belonged to the genus *Haemaphysalis*, represented by 12 species, including a new host specific tick species discovered during this study. Nearly three quarters of all *Haemaphysalis* collected were

H. spinigera, the dominant tick species in the study area, closely followed by *H. wellingtoni* (1073 ticks or 10·9 %) and *H. turturis* (609 ticks or 6·2 %). Small numbers of *H. bispinosa*, *H. intermedia*, *H. p. kinneari*, *H. kyasanurensis*, *H. minuta*, *H. megalaimae*, *H. aculeata*, *H. cuspidata* and one *H. centropi* were also collected in addition to 47 ticks belonging to *Dermacentor auratus*, *Rhipicephalus* sp., *Boophilus* sp. and *Hyalomma marginatum isaaci*. A distinct seasonal pattern both in the infestation rate of birds and also in the number of ticks collected in different months was discernible corresponding with the seasonal pattern of abundance of various stages of ticks in the forest in the study area. All the tick species recorded are indigenous to India. Although 416 birds belonging to 25 species migrating from outside India were examined during the study, not a single tick species not indigenous to India, was collected. The various factors affecting infestation of birds by ticks are also discussed.

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Infestation of *Euryale ferox* Salisb. by larvae of *Nymphula crisonalis* Walker and trials on its Control

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(*With four text-figures*)

INTRODUCTION

The aquatic herb, *Euryale ferox* Salisb., of the family Nymphaeaceae is extensively cultivated in the district of Darbhanga in North Bihar. The habitat chosen for its cultivation are generally the age-old perennial ponds having shallow beds subjected to flooding during rains from the neighbouring streams. Seeds of the plant are parched and beaten and the decoated seeds thus obtained are sold as a highly priced food, the current market rate being rupees eight to ten per kg. Usually, five to six quintals of the seed are annually collected from one acre cultivation, which, in the form of dry edible seed, is one-third of this produce. Obviously, the annual sale proceeds, under normal conditions, exceed rupees one thousand five hundred per acre. The expenditure incurred over its cultivation is very modest as the seeds left over after harvesting germinate out as crop for the next season and it is only the labour which involves some expenditure in thinning out the overgrowths, transplanting into the sparse areas, and in collection of the dispersed seeds from the pond bed during the time of harvesting. Cultivation of this crop, including decoating of the seeds and disposal of the finished produce, happen to be vocation of the fishermen, who, in addition, get some revenue by taking out fish from the water after the main crop is harvested. The significance of this crop, which is so intimately linked up with the livelihood of the fishermen community, can be judged from the fact that on an average 200 quintals of the seed, locally known as ' Makhana ', are transported each year from Darbhanga, besides local consumption.

Lately, the cultivators have complained about the attack on their crop by a caterpillar pest which sometimes assumes menacing proportions. The larval pest, besides eating the blades of early leaves, cuts and rolls a portion of the leaf lamina as a shelter. Earlier attempts to control the pest were limited to picking them off as far as possible. Currently, the cultivators have resorted to indiscriminate use of all kinds of pesticides endangering the fish fauna and the food chain in the aquatic environment.

The present study was undertaken to identify the pest, observe the stage of the plant most susceptible to attack, and to find out a suitable pesticide for its control that would least damage the indigenous fish life and other aquatic biota.

Materials and Methods

Soon after the new set of plants sprouted, close observation was kept to watch the successive stages of the larval pest. Specimens of the infested plants, with caterpillar *in situ*, were removed to the laboratory in earthern pots filled with water and specially prepared for the purpose with a layer of pond silt at the bottom. These pots were covered with fine mesh cloth netting and kept in the open space to provide natural light. At the pupal stage they were carefully detached along with their leaf-lining and floated on water in glass jars covered with netting but with sufficient space for the emerging adult. For first hand information on the dosage of selected pesticides, trials were conducted in large glass jars containing larvae on the leaf blades as in nature. Final trials, on the basis of this information were conducted in large tubs where field conditions were simulated as far as practicable, including transplant of zooplankters and the fish fauna commonly encountered in the *Euryale ferox* habitat.

Results

Susceptible stage of growth of the plant : To recognise the stage of the plant most susceptible to attack by the pest, it is necessary to describe the chronology of foliaceous growth of *Euryale ferox*. Although described as a perennial aquatic herb (Haines 1925 ; Calder & Biswas 1936 ; Subramaniam 1962), the plant, as observed under cultivation here, behaves as a long seasonal or at the most an annual. Fruits mature and burst between September and December and the globular seeds drop to the pond bed. At this stage, fishermen root out the plants as far as possible to facilitate collection of the seeds. It has been observed that, with the onset of winter, the remaining plants also die out. From February onwards, the seeds left over on the pond bed, or those subsequently broadcast, start their hypogeal germination. It may be mentioned here that the thick fibrous roots of the plant described by Calder & Biswas (op. cit.) are actually comprised of 3 to 4 clusters, each cluster containing about 17 rootlets. As the new plant sprouts, the cluster of rootlets come out one after another at an interval of one week or so. Likewise, the foliage pattern also exhibit definite sequence in their appearance. The description given by earlier workers about the large, orbicular, corrugated and peltate leaves with strong spines actually represent the foliage of the fully developed plant, when all the cluster of

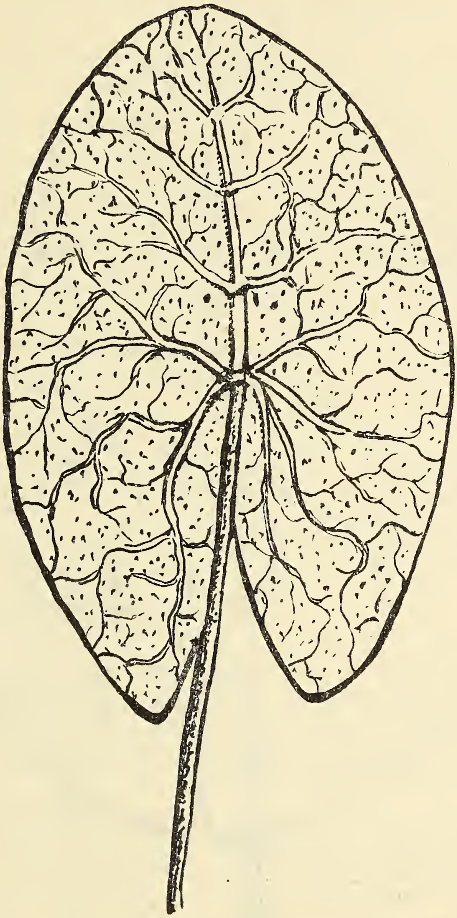

Fig. 1. Leaf of *E. ferox* from the first set.

rootlets have come out and the plant is deeply set in the pond bed. In appearance, the early leaves are quite different from older ones. The first set of leaves are membraneous, deeply sinuate and at the maximum 9 cm long and 8 cm broad. They are deep-pinkish in colour on both the dorsal and the ventral sides, and the stalks are correspondingly tender, having little or no prickles on the lamina. The second set of leaves appear after a fortnight and are more orbicular, moderately sinuate, green above and purplish below, and measure about 15 cm at the longest part with corresponding breadth of 14·5 cm. Their veins are more prominent with spines at places and the petioles are also stiffer, thicker and spiny compared to the leaves of the first set. The typical leaves in the maturing plants start appearing a fortnight later. These are rugose, orbicular, with a slight notch and are green above and dark-purple below. Depending upon the spread area, these leaves vary in length and breadth from 30 to 120 cm and 25 to 110 cm respectively. The veins are highly swollen on the ventral side and are beset with sharp spines which are also profuse on the leaf stalk.

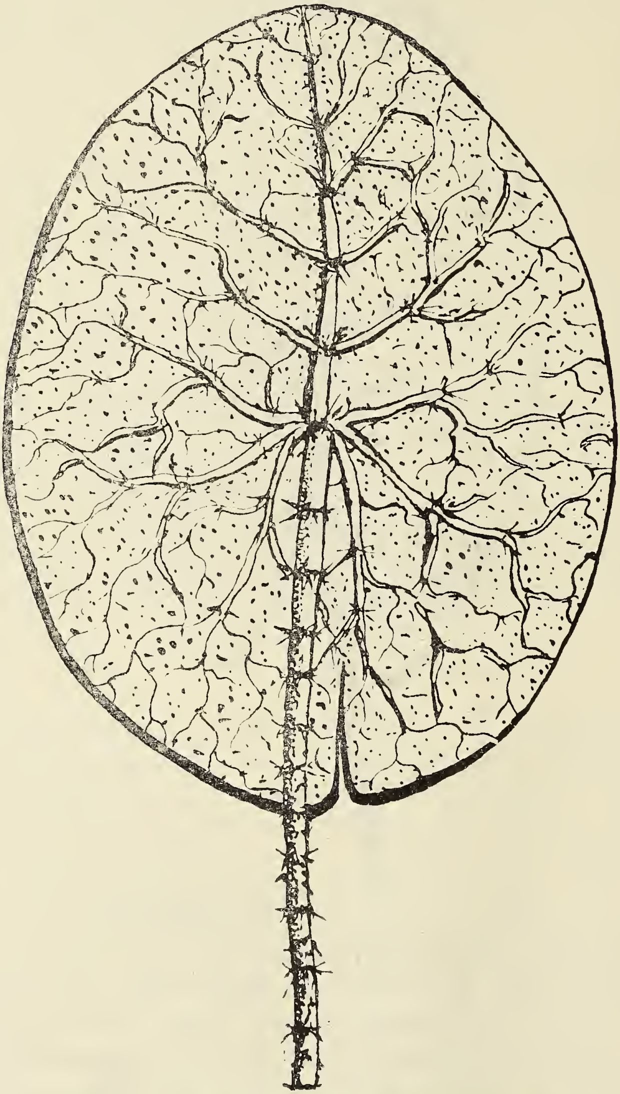

Fig. 2. Leaf of *E. ferox* from the second set.

The foliaceous chronology in the growth of the plant as observed above seems to be an ecological adaptation for its survival. Being a shallow aquatic herb, even moderate surface disturbance has effect right up to the root. The first cluster of roots, would have run the risk of loosing anchor were the early leaves as broad and buoyant as the typical leaves. However, the adaptive feature, while helping the plant to circumvent the hydrological risk, has left it open to the biological risk of the insect pest. As observed in nature, the plants are vulnerable to the pest as long as the earlier set of leaves predominate, but as the broad bladed typical leaves start appearing, it can be taken that the plant has turned the corner, as far as damage from the pest is concerned. A notion prevailing among the cultivators that, with the appearance of the typical leaves, the season for proliferation of the pest was over and that they disappear from the pond was not correct because in the same pond, which had their early leaves of *E. ferox* intensively hit by the larval pest, the larvae continued to be in abundance on another aquatic herb, *Nymphoides cristatum*, growing along the pond margin, after abandoning *E. ferox* with the emergence of typical leaves. It appears the disappearance of the larval pest from *E. ferox* at later stages is linked with the unsuitability to the larvae of the coarser lamina interlaced with rugged veins of the typical leaves.

The early leaves of *E. ferox* also at times swarm with aphids. However, aphids alone do not constitute risk, but the situation is different when the caterpillar attack is already there.

Larva : The late instar of the larva is 15 to 20 mm long and 3 mm wide at the broadest segment. Mandibles rather small. There are between 60 to 100 lateral gills, some of which branch dichotomously. The active larva is yellowish green with a darkish longitudinal streak in the middle of the dorsal surface.

Besides the appearance, the habits of the larval pest as observed conformed to the behaviour of *Nymphula* group described by earlier workers for the species found in their area. Welsch (1966) described the larval case as oval to oblong, filled with water and made out of leaf of the aquatic plants such as *Nuphar*, *Potamegeton*, *Vallisneria* and others found in quiet waters. Clegg (1956), while describing the China mark moths and their larvae, observed later instar of larvae making some kind of protective case from pieces of floating leaf like that of water lily, glued together by their silky secretion. Hampson (1896), while describing the Indian moths, observed that the larvae of some species of *Nymphula* feed on water plants and are best suited for life under water. He, however, did not mention the names of host plants and the details of infestation.

The *Nymphula* larva as pest on *Euryale ferox* was observed in this case to cut the blades of early set of leaves, either in the middle or at the margins, flapping it down the ventral surface or turning it over dorsally, and then gluing it into an oval case 20 to 30 mm long. Under field conditions, the larvae were hardly seen out of their cases. In the laboratory lamina of some of the leaves with the larval case decayed excepting the portion which actually formed the larval case which therefore separated from the plant. The larva then projected its anterior end out of the case and swam about executing jerks alternately on each side, thus pulling the case along till it came across a fresh leaf in which it made

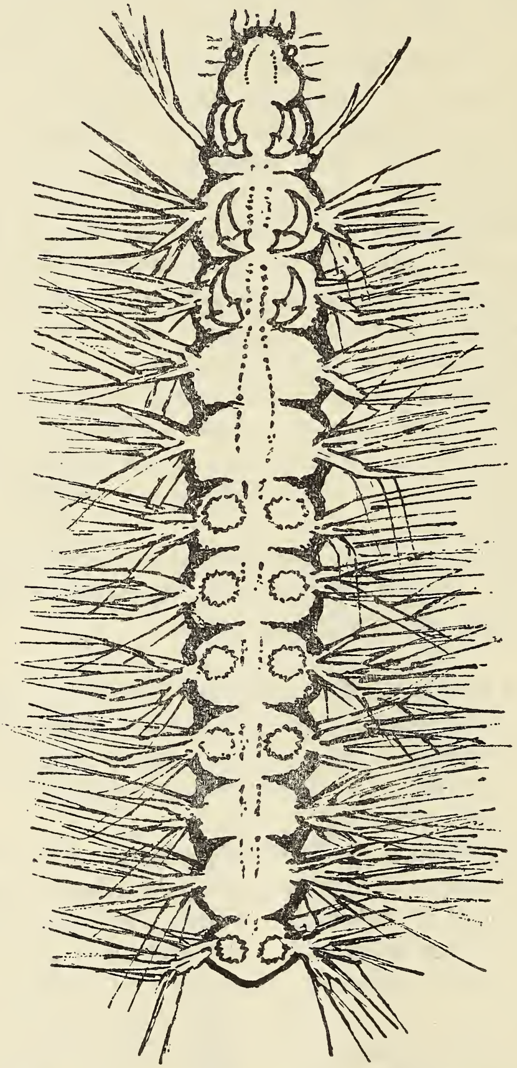

Fig. 3. Ventral view of the larva of *Nymphula*.

a new shelter. Larva moving with leaf case has also been described by Berg (1950) in the case of *N. obscuralis*. It was also observed that once the immature larvae are out of their cases in search of fresh leaves and drop off the plant during the process, they crawl at the bottom and along the stalk until they anchor on to a fresh leaf. The lateral gills are distinctly spread in water, but as soon as they are taken out of water, the gills collapse and become indiscernible. Deprived of moisture, the larvae did not survive for more than a few hours even on the leaves.

Pupa : The later instars of the larvae brought to the laboratory started pupating in 4 to 5 days. The late instars of the larvae and the pupae were found in abundance on *E. ferox* from early March to middle of April. The larval leaf case serves as outer lining for the pupal cases which has yet another padding inside of a silky material. The pupae are 9 to 12 mm long and are of cream colour, including the wings and the appendages save the antennae which are brownish. Before the adult emerges the shade darkens. The wings and appendages are neatly drawn along the ventral side of the body. The wings are not contiguous at any point and are separated out by the appendages. The antennae originate dorsally anterior to the eyes, turn ventrally, and run along the margin

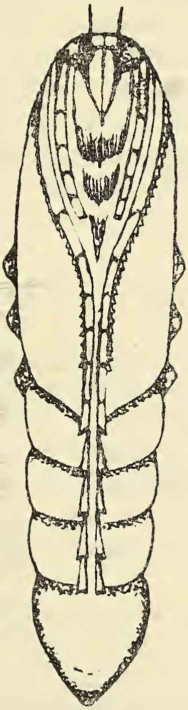

Fig. 4. Ventral view of the Pupa of *Nymphula*.

of the wings terminating a little ahead of the latter's tips. Metalegs reach near the abdominal segments, and the spiracles on the second, third and fourth abdominal segments are all equally prominent and are stubby in appearance. The pupae are found both on the dorsal and ventral surface on the leaf. It was also observed that, if detached from the plant, the pupae float on the water surface and survive as long as they retain the leaf lining. However, if they lose their leaf case, they fall to the bottom and perish.

Adult : A few larvae in their cases were floated on water in separate jars which were covered with cloth netting. The larval cases were taken out at regular intervals and the time of metamorphosing to pupa was noted by moving apart the leaf lining slightly. In all cases observed the pupation was found to last for 11 days. Emergence of the adult from the pupa was always found to be during the night, similar to the observation of Berg (op. cit.). The wings of the adults have chocolate brown ground colour with obscure markings. A thin tawny yellow curved band is noticeable on the forewing. When spread, the rear wings appear a shade lighter in colour. The wing-spread measured about 22 mm. The specimen has been identified to be *Nymphula crisonalis* Walker, by the Zoological Survey of India.

TRIALS ON CONTROL OF THE LARVAL PEST

The pesticides chosen for trial for control of the larval pest were Benzene-hexachloride (BHC), both the ten and the five per cent product, which is being indiscriminately used in field by ' Makhana ' cultivators, and the Phosphamidon-100, available in the market under the trade name Dimecron-100. The latter drug was chosen because it is advocated to be harmless for fish life even up to a concentration of 20 ppm. (Srivastava & Konar 1965) and also because it is reported to be systemic insecticide (Anonymous 1966).

The first set of experiments was conducted in glass jars each containing 6 litres of water and two late instars of the larvae *in situ* on the leaf floated on the water. A sufficient number of zoo-plankton comprising mostly of Cyclops, Diaptomus and Ceriodaphnia were also introduced in each of these jars. The treatments given with one replication of each were : high volume spray of 200 ppm. water solution of Dimecron-100, and dusting of BHC 10 p.c. and 5 p.c. separately at the rate of 10 kg. per hectare. Two jars were kept as control without any treatment. Observations were recorded at 24 hours interval for 6 days. The 200 ppm. Dimecron spray did not seem to have any appreciable effect on the larvae and the plankton also survived. Dusting of 10 p.c. BHC proved highly lethal both for the larvae and the plankton, all dying by the second day of the treatment. In the case of 5 p.c. BHC the larvae died on the second day and the plankton by the fifth day.

The first set of experiments revealed that while BHC ten per cent dusted at the rate of 10 kg. per hectare was lethal both for the larvae and the zooplankton, Dimecron-100, sprayed in a concentration of 200 ppm. on the water surface, was innocuous. The second set of trials was therefore designed to ascertain the lethal dose of Dimecron-100 for the larvae without affecting the zooplankton. Experiments were arranged in the same manner as before and spray of three dilutions of the drug (200, 500 and 1,000 ppm.) was tried. As observed in the case of first trials, spray of 200 ppm. concentrate of Dimecron-100 did not have effect either on the larvae or the plankton. Spray of 500 ppm. concentrate of the pesticide killed the larvae by the fifth day of the treatment, with no noticeable effect on the plankton. Spray of 1,000 ppm. concentrate of the drug quickened the effect on the larvae but proved lethal for the plankton too as all of them died by the third day of the treatment.

On the basis of informations gathered from the two trials, the third set of experiments was designed to study the comparative effects of spray of 500 ppm. dilution of Dimecron-100 and BHC 5 per cent dusted at the rate of 7 kg. per hectare. The set of experiments was arranged as usual and, in addition, contained one specimen each of the fishes *Labeo rohita*, and *Cirrhina mrigala* of 8 to 10 cm length in each of the jars. Corroborating the observations of the second set of trials, spray of the 500 ppm. concentrate of Dimecron-100 killed the caterpillars on the third day of the treatment. Plankton continued to survive save for a slight mortality in one of the replications. The fishes continued to be alive in normal condition. Dusting of the BHC brought the caterpillars to morbid state on first day of the treatment and these were dead on the next day. All the plankton died out by the fourth day and the fishes also expired on the second day.

Although the above experiments were conducted in glass jars, so far as the larval pests are concerned, it is the surface application which matters and therefore the observations made in the aforesaid experiments may be taken as comparable to that of field conditions.

In absence of facilities for field studies, the above results were further tested in large iron drums where field conditions were simulated as far as practicable. Three drums were specially prepared for the purpose by laying 15 cm thick pond silt at the bottom and filled with water up to one metre depth. Infested plant of *E. ferox* with 4 to 5 larvae on the leaves, along with zooplankton consisting of Diaptomus, Cyclops, Ceriodaphnia and Sida hauled from the pond under ' Makhana ' cultivation, was also introduced into each of these drums in sufficient quantity. In addition, each of the drums further contained two specimens each of the fishes *Colisa fasciatus*, *Anabas testudineus*, *Esomus dan-*

ricus, *Barbus sophore*, *Aplocheilus panchax*, which are commonly encountered in *E. ferox* plantations, and two specimens each of *Labeo rohita* and *Cirrhina mrigala*.

Treatment comprised of spraying the surface water with a 500 ppm watery solution of Dimecron-100 in the first drum, and BHC 5 per cent at the rate of 7 kg. per hectare, with an equal quantity of wood ash for uniform dusting, in the second drum. The third drum was kept as control. After the treatment, daily observation was recorded on the behaviour of the larvae and the fishes in the drum and also on the density of plankton in the water. The larvae in both the treated drums died within four days, but observations on fish behaviour and density of plankton in the treated water was continued until the sixth day, after which the water was drained out and the number of fishes, species-wise, that survived in each of the drums was recorded. All the larvae exposed to treatment with BHC died within first two days, while those treated with Dimecron-100 first showed symptoms of dullness, and died on the third and the fourth days. The treatment, however, did not affect the plankton population in any of the drums, as their density remained the same all through the experiment. Among the fishes, casualty was noticed the next day only in *Aplocheilus panchax* exposed to BHC. Both the treatments proved innocuous for other species of fish. The above experiment was repeated again in similar conditions with identical results.

Nymphula Larvae as food for Fishes

To check if fishes would prey upon the free floating larvae, fingerlings of Indian major carps, *Cyprinus carpio*, some minnows, and *Anabas testudineus* were put in glass aquaria which had a known number of living larvae of the *Nymphula*. Excepting the fingerlings of *Cyprinus carpio* and *Anabas testudineus*, which readily took the larvae, the other fishes ignored their presence. *Anabas testudineus* ate the exposed larvae adhering to the ventral surface of the leaves. As under natural condition the larvae mostly keep themselves confined to their cases, the presence of even a good number of these fishes in ' Makhana ' cultivated ponds is not likely to have much impact, even though they might eat away the few larvae hanging out of their cases.

DISCUSSION AND CONCLUSIONS

The economically important aquatic herb, *Euryale ferox*, is highly susceptible to the attack of the larva of *Nymphula crisonalis*. Infestation is confined to the early stages when the plants still have tender and membraneous leaves. With the gradual appearance of thick and stout veined leaves, in about one and a half months from the date of sprouting, the pest disappears from the plant. During the period of susceptibility, therefore, care should be taken to prevent the destruction of the crop. At the same time, care should be taken to see that the control measures adopted do not affect the indigenous fish life and other pond biota, including plankton. All experiments to control the pest were, therefore, conducted with this end in view and the choice of insecticides was limited to BHC and Dimecron-100 (Phosphamidon-100). Then ten per cent product of the former proved too strong and lethal for fishes and other biota and hence it is not recommended for use. The five per cent product of the same drug, dusted at the rate of 7 kg. per hectare, proved lethal to the caterpillar pest, without apparent harm to the crustacean plankton and the indigenous fish fauna, except for *Aplocheilus panchax*, which, by its habit of grazing along the surface film of the water, comes in closer contact with the floating dust of the BHC, and thus succumbs. Dimecron-100, sprayed as a watery solution of 500 ppm. under field conditions, proved effective in killing the larval pest within 3-4 days, without affecting the plankton or fish life.

It would not be out of place to mention that the concentration of Dimecron-100 solution used in these experiments represents the strength of the drug in the quantity of water prepared for spray, which becomes further diluted to a great extent after coming in contact with the water being treated. Since the larvae anchor to the surface floating leaves consideration of the pesticides was confined to the surface treatment only and, therefore, the exact concentration of the drug which became subsequently diluted in the treated water, was not determined. Therefore, the effect of Dimecron-100 on the fish and aquatic biota as observed in this study is not directly comparable to the results obtained by Srivastava & Konar (1956). The comparative cost involved in the use of these two pesticides, apart from labour and other incidental expenses, is for BHC 5 per cent five rupees per hectare at the current market rates. The treatment with Dimecron-100 would require 650 ml. of the drug per hectare the cost of which would come to about seventy rupees. Naturally, the higher cost involved in the use of Dimecron-100 would prompt most of the cultivators to use BHC 5 per cent. However, as BHC has persistent and cumulative effect the use Dimecron-100 despite its higher price should be encouraged. The difference in expenditure would not be much compared to the final return and the revenue derived out of the fish catch after the crop is harvested.

As *Nymphula* attacks *E. ferox* only in the early stages of growth, and infests another aquatic plant, *Nymphoides cristatum*, at other times, there is the possibility of reducing the intensity of infestation by eradicating *N. cristatum* from the waters used for *E. ferox* cultivation. This method of biological control will depend on co-operation among the pond owners and a co-ordinated approach on their part in the matter.

ACKNOWLEDGEMENTS

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Spider Fauna of India: Catalogue and Bibliography

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[*Continued from Vol.* **68** (3) : 618]

Family THERAPHOSIDAE

Genus *CHILOBRACHYS* Karsch 1892

262. **Chilobrachys femoralis** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 195.

Distribution : India : Nasik (Maharashtra).

Type : **BMNH.**

263. **Chilobrachys fimbriatus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 746.

Distribution : India : Khandala, Satara, (Maharashtra).

Type : **BMNH.**

264. **Chilobrachys fumosus** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** : 174.

Distribution : India : Northern India.

Type : **BMNH.**

265. **Chilobrachys hardwickii** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** : 174.

Distribution : India : Bilaspur, Chota Nagpur, Burdwan (West Bengal).

Type : **BMNH.**

266. **Chilobrachys masoni** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** : 174.

Distribution : India : Assam.

Type : **BMNH.**

267. **Chilobrachys stridulans** Wood-Mason 1875. *P.A.S.B.*, p. 197.

Distribution : India : Sibsagar (Assam).

Type : ?

268. **Chilobrachys thorellii** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 199.

Distribution : India : Sadiya (Assam).

Type : **BMNH.**

Genus *HAPLOCLASTUS* Simon 1892

269. **Haploclastus cervinus** Simon 1892. *Hist. Nat. Araign. Paris* **1** : 152.

Distribution : India : Palni Hills.

Type : **MNHN.**

270. **Haploclastus nilgirinus** Pocock 1889. *J. Bombay nat. Hist. Soc.* **12** : 747.

Distribution : India : Nilgiri Hills.

Type : **BMNH.**

Genus *HETEROPHRICTUS* Pocock 1900

271. **Heterophrictus milleti** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 180.

Distribution : India : Nasik, Poona, Satara (Maharashtra).

Type : **BMNH.**

Genus *ISCHNOCOLUS* Ausserer 1871

272. **Ischnocolus linteatus** Simon 1891. *Ann. Soc. Ent. France* **60** : 308.

Distribution : India : Pondicherry, Madras.

Type : **MNHN.**

Genus *LYROGNATHUS* Pocock 1895

273. **Lyrognathus crotalus** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** : 175.

Distribution : India : North India.

Type : **BMNH.**

274. **Lyrognathus pugnax** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 203.

Distribution : India : Shillong (Assam).

Type : **BMNH.**

275. **Lyrognathus saltator** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 203.

Distribution : North Khasi Hills (Assam).

Type : **BMNH.**

Genus *PHLOGIELLUS* Pocock 1897

276. **Phlogiellus subarmatus** Thorell 1891. *Sv. Vet.-Akad. Handl.* **24** (2) : 13.

Distribution : India : Nicobar Islands.

Type : **BMNH.**

Genus *PHLOGIODES* Pocock 1899

277. **Phlogiodes robustus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 748.

Distribution : India : Matheran, Bombay (Maharashtra).

Type : **BMNH.**

278. **Phlogiodes validus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 748.

Distribution : India : Matheran, Bombay (Maharashtra).

Type : **BMNH.**

Genus *PLESIOPHRICTUS* Pocock 1899

279. **Plesiophrictus collinus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 749.

Distribution : India : Shevaroy Hills (Tamil Nadu).

Type : **BMNH.**

280. **Plesiophrictus fabrei** Simon 1892. *Ann. Soc. Ent. France* **61** : 278.

Distribution : India : S. India.

Type : **MNHN.**

281. **Plesiophrictus millardi** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 749.

Distribution : India : Matheran, Bombay (Maharashtra).

Type : **BMNH.**

282. **Plesiophrictus sericeus** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 182.

Distribution : India : Poona (Maharashtra).

Type : **BMNH.**

Genus *POECILOTHERIA* Simon 1885

283. **Poecilotheria fasciata** Latreille 1803. *Nouv. Dict. d'Hist. Nat.* **15** : 304.

Distribution : India : Madura, Madras : Ceylon.

Type : ?

284. **Poecilotheria formosa** Pocock 1899. *Ann. Mag. Nat. Hist.* **3** (7) : 91.

Distribution : India : Kadiampatti, Mallapuram, S. India.

Type : **BMNH.**

285. **Poecilotheria metallica** Pocock 1899. *Ann. Mag. Nat. Hist.* **3** (7) : 93.

Distribution : India : Ootacamund (Tamil Nadu).

Type : **BMNH.**

286. **Poecilotheria miranda** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 190.

Distribution : India : West Bengal, Chota Nagpur.

Type : **BMNH.**

287. **Poecilotheria regalis** Pocock 1895. *Ann. Mag. Nat. Hist.* **3** (7) : 89.

Distribution : India : Western India, Matheran, Thana, Bombay (Maharashtra) ; Nilgiri Hills ; Coorg (Mysore).

Type : **BMNH.**

288. **Poecilotheria rufilata** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 746.

Distribution : India : Trivandrum (Kerala).

Type : **BMNH.**

289. **Poecilotheria striata** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** (6) : 172.

Distribution : India : Mysore ; Trivandrum (Kerala).

Type : BMNH.

290. **Poecilotheria vittata** Pocock 1895. *Ann. Mag. Nat. Hist.* **15** (6) : 172.

Distribution : India or Ceylon (exact place unknown).

Type : BMNH.

Genus *SELENOCOSMIA* Ausserer 1871

291. **Selenocosmia himalayana** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 746.

Distribution : India : Dehra Dun (U.P.)

Type : BMNH.

292. **Selenocosmia javanensis** Walckenaer 1837. *Ins. Apt.* **1** : 216.

Distribution : India : Nicobar Islands.

Type : ?

Genus *THRIGMOPOEUS* Pocock 1899

293. **Thrigmopoeus insignis** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 747.

Distribution : India : Kanara Ghats (Mysore).

Type : BMNH.

294. **Thrigmopoeus truculentus** Pocock 1899. *J. Bombay nat. Hist. Soc.* **12** : 748.

Distribution : India : Karwar (Mysore).

Type : BMNH.

Family THERIDIDAE

Genus *THERIDION* Walckenaer 1805

295. **Theridion rufipes** Lucas 1846. *Explor. Sci. Algeria Arachn.* **1** : 263, tab. 16, fig. 5.

Distribution : India : Siju Cave, Garo Hills (Assam).

Type : ?

Genus *ARGYRODES* Simon

296. **Argyrodes cyrtophore** Tikader 1963. *Proc. Indian Acad. Sci.* **57** : 99, fig. 1a-c.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

297. **Argyrodes dipali** Tikader 1963. *Proc. Indian Acad. Sci.* **57** : 103, fig. 4a-c.

Distribution : India : Mundhva, near Poona City (Maharashtra).

Type : **ZSI.**

298. **Argyrodes gouri** Tikader 1963. *Proc. Indian Acad. Sci.* **57** : 102, fig. 3a-c.

Distribution : India : Mundhva, near Poona City (Maharashtra).

Type : **ZSI.**

299. **Argyrodes jamkhedes** Tikader 1963. *Proc. Indian Acad. Sci.* **57** : 101, fig. 2a-c.

Distribution : India : Sarola village, Jamkhed Taluka, Dist. Ahmednagar (Maharashtra).

Type : **ZSI.**

Genus *LATHRODECTUS* Walckenaer 1805

300. **Lathrodectus hasseltii** Thorell 1870. *Oefv. K. Sv. Vet.-Akad. Forh.* **27** : 369.

Distribution : India : Poona, Bombay (Maharashtra) : Karachi (Pakistan).

Type : **BMNH.**

301. **Lathrodectus hasseltii indicus** Simon 1897. *Bull. Mus. Hist. Nat.*, p. 97.

Distribution : India : Poona, Bombay (Maharashtra).

Type : **MNHN.**

Family THOMISIDAE

Genus *AMYCIAEA* Simon 1885

302. **Amyciaea forticeps** (Cambridge) 1873.

Amycle forticeps Cambridge 1873. *Proc. Zool. Soc. London* : 122

Distribution : India : Poona (Maharashtra) ; Burma ; Malaysia.

Type : **BMNH.**

Genus *ANGAEUS* Thorell 1881

303. **Angaeus pantagonalis** Pocock 1901. *J. Bombay nat. Hist. Soc.* **13** : 497.

Distribution : India : Nilgiri Hills (S. India).

Type : **BMNH.**

Genus *APOLLOPHANES* Cambridge 1898

304. **Apollophanes bengalores** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 260, fig. 10.

Distribution : India : Bangalore (Mysore).

Type : **ZSI.**

Genus *BOMIS* Koch 1873

305. **Bomis bengalensis** Tikader 1962. *J. Linn. Soc. London* **44** : 580, fig. 11a-b.

Distribution : India : West Bengal.

Type : **ZSI.**

Genus *DIAEA* Thorell 1869

306. **Diaea jaintious** Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 59.

Distribution : India : Shillong, Cherapunjee (Assam).

Type : **ZSI.**

Genus *EBO* Keyserling 1884

307. **Ebo bharatae** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 278, fig. 2a-e.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

Genus *MISUMENA* Latreille 1804

308. **Misumena greenae** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 281, fig. 5a-c.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

309. **Misumena horai** Tikader 1962. *J. Linn. Soc. London* **44** : 573, fig. 5a-e.

Distribution : India : Shillong (Assam).

Type : **ZSI.**

310. **Misumena menoka** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 254, fig. 5a, b.

Distribution : India : Mysore and Maharashtra.

Type : **ZSI.**

311. **Misumena mridulai** Tikader 1962. *J. Linn. Soc. London* **44** : 57, fig. 6.

Distribution : India : Shillong (Assam).

Type : **ZSI.**

312. **Misumena silveryi** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 282, fig. 6 a, b.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

Genus *MISUMENOIDES* Cambridge 1900

313. **Misumenoides deccanes** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 279, fig. 3 a, b.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

314. **Misumenoides kripalaniae** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 258, fig. 8 a, b.

Distribution : India : Chikmagalur (Mysore).

Type : **ZSI.**

315. **Misumenoides shulli** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 280, fig. 4 a, b.

Distribution : India : Mussoorie (U.P.).

Type : **ZSI.**

Genus *MISUMENOPS* Cambridge 1900

316. **Misumenops khandalaensis** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 287, fig. 11a-c.

Distribution : India : Khandala Ghat (Maharashtra).

Type : **ZSI.**

Genus *MONAESES* Thorell 1870

317. **Monaeses parvati** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 249, fig. 1a-c.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

Genus *OXYPTILA* Simon 1864

318. **Oxyptila khasi** Tikader 1960. *Proc. Zool. Soc., Calcutta* **13**: 116, fig. 2a-c.

Distribution : India : Shillong (Assam).

Type : **ZSI.**

319. **Oxyptila manii** Tikader 1960. *Proc. Zool. Soc., Calcutta* **13**: 115, fig. 1a-d.

Distribution : India : West Bengal.

Type : **ZSI.**

320. **Oxyptila maratha** (Tikader) 1964.

Oxyptila gertschi Tikader 1964. *Sci. and Cult.* **30**: 152, Fig. 1 a-c.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

321. **Oxyptila reenae** Basu 1964. *Sci. and Cult.* **30** : 154.

Distribution : India : West Bengal.

Type : **ZSI.**

Genus *PASIAS* Simon 1895

322. **Pasias maratha** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 286, fig. 10 a, b.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

323. **Pasias puspagiri** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 253, fig. 4.

Distribution : India : Hassan (Mysore).

Type : **ZSI.**

Genus *PHILODROMUS* Walckenaer 1825

324. **Philodromus assamensis** Tikader 1962. *J. Linn. Soc. London* **44** : 581, fig. 12 a-c.

Distribution : India : Shillong (Assam).

Type : **ZSI.**

325. **Philodromus betrabatai** Tikader 1966. *Proc. Linn. Soc. London* **177** : 35, fig. 1 a, b.

Distribution : India : Poona (Maharashtra).

Type : **ZSI.**

326. **Philodromus bhagirathai** Tikader 1966. *Proc. Linn. Soc. London* **177** : 36, fig. 2 a, b.

Distribution : India : Allahabad (U.P.) ; Madras.

Type : ZSI.

327. **Philodromus decoratus** Tikader 1962. *J. Linn. Soc. London* **44** : 582, fig. 13.

Distribution : India : Shillong (Assam).

Type : ZSI.

328. **Philodromus devhutai** Tikader 1966. *Proc. Linn. Soc. London* **177** : 42, fig. 6 a, b.

Distribution : India : Poona (Maharashtra).

Type : ZSI.

329. **Philodromus domesticus** Tikader 1962. *Proc. Zool. Soc., Calcutta* **15** : 39, fig. 1 a, b.

Distribution : India : Shillong (Assam).

Type : ZSI.

330. **Philodromus kendrabati** Tikader 1966. *Proc. Linn. Soc. London* **177** : 58, fig. 3 a, b.

Distribution : India : Poona (Maharashtra).

Type : ZSI.

331. **Philodromus maliniae** Tikader 1966. *Proc. Linn. Soc. London* **177** : 39, fig. 4 a, b.

Distribution : India : Poona (Maharashtra).

Type : ZSI.

332. **Philodromus mohiniae** Tikader 1966. *Proc. Linn. Soc. London* **177** : 40, fig. 5 a, b.

Distribution : India : Poona (Maharashtra).

Type : ZSI.

333. **Philodromus shillongensis** Tikader 1962. *Proc. Zool. Soc., Calcutta* **15** : 40, fig. 2 a, b.

Distribution : India : Shillong (Assam).

Type : ZSI.

Genus *PISTIUS* Simon 1875

334. **Pistius barchensis** Basu 1965. *Proc. Zool. Soc., Calcutta* **18** : 74.
Distribution : India : Dehra Dun (U.P.).
Type : ZSI.

335. **Pistius bhadurii** Basu 1965. *Proc. Zool. Soc., Calcutta* **18** : 71.
Distribution : India : Saharanpur Dist. (U.P.).
Type : ZSI.

336. **Pistius gangulyi** Basu 1965. *Proc. Zool. Soc., Calcutta* **18** : 73.
Distribution : India : Dehra Dun (U.P.).
Type : ZSI.

337. **Pistius kanikae** Basu 1964. *J. Bengal nat. Hist. Soc.* **32** : 107.
Distribution : India : Lakshamanjhola (U.P.).
Type : ZSI.

338. **Pistius robusta** Basu 1965. *Proc. Zool. Soc., Calcutta* **18** : 75.
Distribution : India, Dehra Dun (U.P.).
Type : ZSI.

339. **Pistius roonwali** Basu 1964. *J. Bengal nat. Hist. Soc.* **32** : 104.
Distribution : India : Hardwar (U.P.).
Type : ZSI.

340. **Pistius sreeponchamii** Tikader 1962. *J. Linn. Soc. London* **44** : 871, fig. 4 a, b.
Distribution : India : Shillong (Assam).
Type : ZSI.

(*to be continued*)

A Catalogue of the Birds in the Collection of the Bombay Natural History Society—11

Strigidae and Caprimulgidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **68** (3) : 772]

This part covers 583 specimens of 93 species and subspecies upto No. 682 in INDIAN HANDBOOK (**4** : 23). Mr. S. A. Hussain, Research Assistant, assisted with the measurements and in other ways.

606 **Tyto alba stertens** Hartert (Cachar) Indian Barn Owl **4** : 385

25 : 9 ♂♂ 9 ♀♀ 7 o ? (2 pull.)

1 Ambala, Punjab ; 1 Simla ; 1 Larkhana, Sind ; 1 Kutch, 1 Radhanpur, 1 Nadiad, 1 West Khandesh ; 1 Ghoti, Nasik, 6 Bombay, 2 Nagpur ; 1 Point Calimere, Tamil Nadu ; 1 Koreput, Vizagapatam ; 1 Narah, Madhubani, Bihar ; 1 Calcutta Market ; 1 Bharmabari, Bhutan Duars ; 1 Dinapur Road, Manipur, 1 Imphal Area ; 1 *Swebo*, 1 *near Sagaing* (*Upper Burma*).

There is considerable variation in the amount of rufous on the upper and lower plumages but it is not possible to group them. The birds from Upper Burma are identical with the others.

607 **Tyto alba deroepstorffi** (Hume) (Aberdeen, South Andamans) Andaman Barn Owl **4** : 386

1 o ? North Cinque Island, Andamans.

Wing	Bill	Tarsus	Tail
258 (♂♀ 250-264)	30 (*c*. 32)	63 (*c*. 61)	110 (*c*. 113)

This bird is quite distinct from Indian birds and is probably of this race. Hume, when describing it, said the colour of the upper surface was intermediate between *S. flammea* (*T. a. stertens*) and *S. candida* (*T. c. longimembris*). Except for the slight speckling with rufous, the present specimen is as dark as *longimembris*.

EL **Tyto alba erlangeri** W. L. Sclater (Lahej, Arabia)

1 ♀ *Muscat, Arabia.*

Wing	Tail
294	122

608 **Tyto capensis longimembris** (Jerdon) (Neilgherries) Grass Owl 4 : 387

3 : 2 ♂♂ 1* o ? (fragmentary)

1* Taliar, High Range, Kerala ; 1 Rajputee, Chupra, Bihar ; 1 Imphal, Assam.

Wing	Bill	Tarsus	Tail
337,340	32, 33	82, 87	114, 117
(♂♀ 305-348)	(*c.* 36)	(86-94)	(114-125)

609 **Phodilus badius saturatus** Robinson (Native Sikkim) Sikkim Bay Owl 4 : 390

2 o ?

1 Shillong ; 1 *Mansam Falls, North Shan States.*

Wing	Bill	Tarsus	Tail
220, 220	32, 33	45, 49	95, 96
(♂♀ 214-237	30-32	47-48	92-97)

610 **Phodilus badius assimilis** Hume (Ceylon) Ceylon Bay Owl 4 : 391

nil.

611 **Otus spilocephalus huttoni** Hume (Near Mussoorie) Western Spotted Scops Owl 4 : 429

8 : 4 ♂♂ 3 ♀♀ 1 o ?

2 Simla, 1 Patiala State ; 4 Mussoorie, 1 Bhim Tal, Kumaon.

	Wing	Bill	Tarsus	Tail
8 ♂♀	136-145	16-18	29-32	65-72
	(135-144	*c.* 17	30-31	71-76)

A juvenile *Otus bakkamoena* from Dhulia, West Khandesh, was listed as *spilocephalus.*

612 **Otus spilocephalus spilocephalus** (Blyth) (Darjeeling) Eastern Spotted Scops Owl 4 : 427

2 ♀♀ 1 Margherita, 1 Dibrugarh, Assam.

Wing	Bill	Tarsus	Tail
142, 146	19, 20	30, 30	79, 82
(137-151	*c.* 17-18	*c.* 31-32	77-90)

613 **Otus balli** (Hume) (South Andaman Island) Andaman Scops Owl.

nil.

614 **Otus brucei** (Hume) (Rahuri, Ahmednagar) Striated Scops Owl 4 : 431

13 : 6 ♂♂ (1 pull.) 4 ♀♀ 3 o ? (2 pull.)

1 *Muscat ;* 2* *Baghdad,* 1 *Hilla,* 1 *Basra ;* 1 *Bandar Rig,* 2 *Shiraz ;* 1* Surja Patti, Kharan (Baluchistan) ; 1 Padgha, Thana, 1 Poona, 1 Ratnagiri, Maharashtra, 1 no data (*Type and paratype of *exiguus*).

The key in IND. HANDBOOK (3 : 255) separates *brucei* from *scops* by the feathers of tarsus extending on to base of toes in *brucei* and not extending on to base of toes in *scops*. In the material available, I cannot see this difference, the feathering extending on to the base of the toes in both species. Vaurie [1960, *Am. Mus. Nov.* 2021, p. 2, quoting Dementiev 1933, SYSTEMA AVIUM ROSSICARUM, *L'Oiseau*, new series, *Vol.* 3 (Strigidae), pp. 501-518] separates them by the third primary being equal to or less than the sixth in *brucei*, and distinctly larger than the sixth in sympatric subspecies of *scops*. This appears an excellent character for their separation.

The two old skins from Poona (22 Dec. 1882) and Ratnagiri (8 June 1874) have earthy-brown upper parts which, but for Hume's description, I would have said were faded. The third from Thana, Bombay, (25 Dec. 1960), is grey like most of the others. IND. HANDBOOK (**3** : 259) states that young birds are grey.

In 1958, Mukherjee, *Rec. Ind. Mus.* **53** : 301, separated west Asian birds as *exiguus* (Type locality : Baghdad), partly by colour and for its smaller size. This has been generally discarded but the three from peninsular India, where it is almost certainly a winter migrant, have larger wings and tails than the others.

		Wing	Tail
1 ♂ 2 ♀♀ Poona, Thana, Ratnagiri		163, 163, 165	78, 80, 80
Others:	4 ♂♂	150, 153, 155	70, 72, 74, 80
	2 ♀♀	150, 159	69, 75
	(♂♀	150-161	78-82)

Another in St. Xavier's High School collection, obtained at Andheri, Bombay, on 18 Nov. 1965, has a 163 mm. wing.

Of the 3 pullets listed as of this species, No. 11944 from Hilla, Mesopotamia, is paler than the others. As stated by Vaurie (*loc. cit.*) these are distinguished from juvenile *scops* by being paler, and barred on the underparts, while those of *scops* are like the adults. The wing formulae do not apply to the pullets, but this is presumably not surprising. It may be mentioned that all the three have a finely barred head-cap, not unlike that in juvenile *bakkamoena*. The distribution in INDIAN HANDBOOK limits the winter range southwards to Bombay, overlooking the Poona and Ratnagiri specimens, the latter having been referred to in Stuart Baker's FAUNA.

615 **Otus scops pulchellus** (Pallas) (' Copiosius in australioribus ad Volgam, Samaram, Iaicum ') Eastern Scops Owl **4** : 433

The type locality is mentioned as Siberia in Stuart Baker's FAUNA.

10 : 4 ♂♂ (1* pull.) 4 ♀♀ 2 o ?

1 *Amara, Iraq* ; 1 *Teheran*, 1**Bagh Takht* (?), 1 *Bunder Abbas, Iran* ; 1 Gilgit, 3 Chitral ; 1 Bombay City ; 1 Khandala, 2000′ Poona.

[195]

	Wing	Bill	Tarsus	Tail
9 ♂♀	150-160 av. 155	16-18 av. 17	26-29 av. 27	64-70 av. 67
	(150-158	16-17	*c.* 26	66-71)

This form can be distinguished from the other species of *Otus* by having the fourth quill shorter than the third (with which the second is sometimes subequal) and from the other subspecies by the first primary being longer than the sixth.

The pullet from Bagh Takht, with its wings and tail still in moult, is very similar to the adult. The records from peninsular India almost certainly refer to winter migrants. Two examined at the Zoological Survey of Pakistan, Karachi, were obtained at Ghizri, Karachi, on 1 and 7 October.

616 **Otus scops sunia** (Hodgson) (Nepal) North Indian Scops Owl 4 : 435

9 : 5 ♂♂ 2 ♀♀ 2 o ? (1 juv.) (5* rufous)

1* Simla ; 1* Delhi ; 1* Khandala, 2000′ Poona ; 1* Gaya, Bihar ; 1* Sikkim ; 3 Bhutan Duars ; 1 Butri, Buxa Duars.

	Wing	Bill	Tarsus	Tail
9♂♀	143-150 av. 146·4	17-19 av. 18	24-26 av. 25	60-70 av. 65
	(137-154	16-18	26-28	61-71)

The name *sunia* is from the Hindi *sona*=gold.

The rufous phase affects both sexes, and there is no difference in size. A rufous juvenile (11965 o ?) has only the upper wing coverts and the tail rufous, the rest showing a pale washed-out rufous.

The key to the subspecies of *Otus scops* in IND. HANDBOOK (3 : 261) requires the fourth primary longest, or equal to the third in *sunia*, *modestus*, *rufipennis*, and *leggei*, but this conflicts with the earlier (p. 255) key to species which separates all races of *Otus scops* from the other species of *Otus* in having the third quill longest. The present specimens can be separated from *pulchellus* by their smaller wings and in the first primary not being longer than, but equal to or appreciably shorter than the sixth.

Specimen No. 20872, a rufous female from Khandala (10 Nov.), can be so separated from No. 20312, another normally-coloured female from the same place and which is listed as *pulchellus*, presumably a migrant. The former intrudes upon the range of *rufipennis* as in IND. HANDBOOK (3 : 263)—from northern Maharashtra (Khandesh, *c.* 21° N) south-eastwards to Kerala.

617 **Otus scops rufipennis** (Sharpe) (Eastern Ghats, Madras) Peninsular Scops Owl 4 : 434

2 ♂♂ (1* rufous)

1* Sholapur ; 1 Supa, Ka.

Wing	Bill	Tarsus	Tail
133, 138	18, 20	23, 25	57, 60
(♂♀ 122-135	17-18	25-26	52-62)

The first primary in both specimens is shorter than the fifth (and sixth) and not equal or longer, as required in IND. HANDBOOK.

618 **Otus scops leggei** Ticehurst (Ceylon) Ceylon Scops Owl 4 : 434
nil.

618a **Otus scops modestus** (Walden) (Port Blair) Andaman Scops Owl 4 : 437

1 ♀ Wrightmyo-Mannarghat, South Andamans.

The distal portion of the tarsus is bare and, though similar to that in *O. s. nicobaricus* (Hume), is quite different from that in other races of *scops* available for examination. This bird was originally recorded as *O. balli* and was re-identified by Dr. Biswas while at the British Museum. The sixth primary is damaged but appears to have been longer than the first.

The wing and tail are damaged but IND. HANDBOOK (3 : 265) measures 5 specimens wings 140-143, tail (1) 62. These measurements are smaller than for *O. balli* quoted in the same work, and I cannot understand why it is referred to as the Andaman *Lesser* Scops Owl. Blanford (3 : 296) states that *modestus* is the young of *balli.*

618b **Otus scops nicobaricus** (Hume) (Camorta, Nicobars) Nicobar Scops Owl

1 ♂ Campbell Bay, Great Nicobar. Breeding.

Wing 164, Bill 23, Tarsus 30, Tail 78.

This bird does not agree with the original description but was identified by Biswas at the British Museum. The wing lacks the white edge common to the other races and the lower belly is also as profusely marked as the breast. Ticehurst (*Ibis*, 1923, p. 243) synonymises this with *malayanus* (Hay), holding that Hume's type was a cinnamon-bay phase. He measures the wings of a 'good series from Malacca, one from Tennasserim and two from Nicobars' as 134-148.

Though required for all races of *O. scops* in IND. HANDBOOK (3 : 255), in the two specimens named *modestus* (No. 21963) and *nicobaricus* (22578) the first primary is not longer than the eighth.

619 **Otus bakkamoena plumipes** (Hume) (India=Murree, Punjab) Punjab Collared Scops Owl 4 : 425

2 : 1 ♂ 1 ♀

1 Simla, 1 Rambag, Kumaon.

	Wing	Bill	Tail
♂♀	175, 184	22, 23	84, 83
	(175-184	22, 23	83, 84)

The toes are feathered down to the subterminal phalanx, a character which immediately separates them.

620 **Otus bakkamoena deserticolor** Ticehurst (Hyderabad, Sind) Pakistan Collared Scops Owl 4 : 426

1 ♂ pullet, Nandero, Larkana, Sind.

This has the typical speckled ' cap ' of the species and is paler than the young of *marathae* and nominate *bakkamoena*. INDIAN HANDBOOK (**3** : 267) refers to two specimens from Bushire (Persian Gulf) and Muscat (Southern Arabia) in the B.N.H.S. collection. These are not traceable, and may be in error for Ticehurst's (*Ibis*, 1923, p. 240) reference to young from the same places, one being in the Karachi Museum, repeated by Stuart Baker (**4** : 426).

621 **Otus bakkamoena gangeticus** Ticehurst (Fategarh, U.P.) Gangetic Collared Scops Owl **4** : 425

6 : 1 ♂ 1 ♀ 4 o ? (1 pull.)

3 Tirhut, 1 Saran, Bihar ; 1 Morang, Nepal (Terai ?) ; 1 Bhutan Duars.

Wing	Bill	Tail
155-162 av. 159	Tipped black	73-77 av. 75

[146-167 FAUNA ; 153-167, mostly 155-162 (19 measured) IH ex Ticehurst]

All the specimens are earthy brown above and quite distinct from all the others.

622 **Otus bakkamoena marathae** Ticehurst (Raipur, C.P.) Central Indian Collared Scops Owl **4** : 424

7 : 4 ♂♂ (2 pull.) 2 ♀♀ 1 o ? (pull.)

3 Chikalda, 1 N. Chaurakund, 1 Raipur, Melghat, Berar ; 2 Khandala.

Wing	Tail
143, 145, 147, 148	66(2), 67, 71

[IH ex Ticehurst 145-157 FAUNA ; 152-162, once 165 (41 measured)]

The larger sizes quoted are no doubt due to inclusion of *stewarti* Koelz (See No. 624a).

623 **Otus bakkamoena bakkamoena** Pennant (Ceylon) Ceylon Collared Scops Owl **4** : 422

8 : 5 ♂♂ (2 pull.) 2 ♀♀ 1 o ? (pull.)

1 Dhulia ; 1 ' died in Society's rooms ' ; 2 Karwar ; 2 Palni Range ; 2 Trivandrum Zoological Gardens (?)

Wing	Tail
145 (Karwar)-155 (Palni Range) av. 148	66-68 av. 67
(IH 135-152, once 154, ex Ticehurst)	(64-74)

The tail from the FAUNA is quoted as 64-67 in INDIAN HANDBOOK (**3** : 270). There is variation in the colour of the upper and lower parts, some being more rufous than the others. In series they are much darker than all the others.

Two from Karwar and the Dhulia pullet differ from all the others except *plumipes* (2) and *lettia* (8) in having the bill all yellow, instead of being tipped with blackish.

Deignan (1950, *Auk* **67** : 199) measures one south Indian bird wing 160 mm. and doubts the correctness of including them with the nominate form.

624 **Otus bakkamoena lettia** (Hodgson) (Nepal) Burmese Collared Scops Owl **4** : 427

8 : 2 ♂♂ 5 ♀♀ 1 o?

1 Hasimara, Bhutan Duars ; 1 Darjeeling ; 1 Rongni Valley, Sikkim ; 1 Marta, 1 Cachar, Assam ; 1 Beltung (?) ; 1 *Dalat*, 20°N., 93° 51′E ; 1 *Tennasserim River, Burma.*

Wing	Tail
159-171 av. 165	76-88 av. 81
(IH 162-182 ex Ticehurst)	

The males are smaller than the females as indicated in INDIAN HANDBOOK.

The usual variation in colour exists, but in series they approach nominate *bakkamoena*, which are darker.

624a **Otus bakkamoena stewarti** Koelz (Baijnath, Kangra, Punjab)

7 : 4 ♂♂ 2 ♀♀ 1 o?

1 Simla Hills ; 2 Chandigarh, 1 Karnal, Punjab ; 1 Delhi ; 1 Sironj, Tonk, Rajasthan ; 1 Balaghat, M.P.

(See note on validity of this subspecies *JBNHS* **68** : 829-830)

624b **Otus bakkamoena** subsp.

1 ♀ 2700′, Lamasinghi, Vizagapatam Ghats, A.P.

The single specimen (wing 170, bill 23, tarsus 30, tail 81) recently obtained by the migration study camp resembles nominate *bakkamoena* in its rich rufous underparts, and dark upperparts, but is large and nearer *lettia* in size. Jerdon (1844, *Madras J. Lit. & Sc.*, **XIII**, p. 119) described *Scops griseus* from the forests of the Eastern Ghats which, he said, closely resembled Hodgson's *lettia* in colour but was small like *bakkamoena* from Malabar !

625 **Bubo bubo** subsp. Eagle-Owl

4 : 2 ♂♂ 2 ♀♀

1 Kozdar, Kalat, Baluchistan ; 1 Chitral, 2 Chaklala, N.W.F.P.

Wing ♂♂ 375, 390 ♀♀ 401, 404
(♂♀ *turcomanus* 435-513 ; Vaurie ♂♂ 440-470 av. 449·7 ♀♀ 445-512)
Bill ♂♀ 44(4) (45-47)
Tarsus ♂♀ 70, 74, 75(2) (77-81)
Tail ♂♀ 200,210 (2), 219 ♀ (260-310)

These birds differ from others under *bengalensis* in their paler and yellower upper parts. According to the distribution in INDIAN HANDBOOK, they should include both *hemachalana* Hume (from Kalat) and *turcomanus* (Eversmann) (from Chitral), but the specimens are much smaller than either.

Another ♀ from '25 m. from Srinagar, Kashmir' in St. Xavier's High School, Bombay, collection, is greyer above, but the wing measures 398, and the tail 220.

626 **Bubo bubo tibetanus** Bianchi (Upper Yangtse River in South-eastern Tibet) Tibetan Horned or Eagle-Owl 4 : 414

nil.

See under 625.

626a **Bubo bubo hemachalana** Hume (Kulu, 12,000 feet, India) Himalayan Horned or Eagle-Owl

nil.

See under 625

627 **Bubo bubo bengalensis** (Franklin) (The Ganges between Calcutta and Benaras and in the Vindhyan Hills between the latter place and Gurra Mundela) Indian Great Horned or Eagle-Owl 4 : 414

16 : 5 ♂♂ 5 ♀♀ 6 o ? (1 juv. 1 chick)

1 Pithoro, Sind ; 1 Bhattu, Hissar, Punjab ; 1 Bilara, Jodhpur, Rajasthan ; 2 Gwalior, M.P. ; 1 Shadi River, 1 Virdi, Kaira, 1 Kanta, Nadiad ; 1 Ahmednagar, 1 Bombay Market ; 1 Manalur, Palni Foothills ; 1 Shahgarh, 1 Lucknow, 1 Fyzabad, 1 Dehra Dun, U.P. ; 1 no data.

The juvenile is paler and lacks the streaks on the breast.

There is some variation in the colour of the upper and lower parts but the differences cannot be localized. Sp. Nos. 23304 ♂ from Manalur, Palni Foothills, and 20869 with no data, have heavy black markings on the upper parts, almost obliterating the rufous.

	Wing	Bill	Tarsus	Tail
5 ♂♂	360-396 av. 375	43-45 av. 44	71-75 av. 72·5	185, 186, 195, 210
	(IH 364-390	—	69-76	185-195)
5 ♀♀	376-390 av. 382	42-44 av. 43·6	73-75 av. 73·8	190-216 av. 206
	(IH 375-425	—	70-75	205-227)

EL **Bubo bubo nikolskii** Zarudny (Bakhtiari, Southwestern Iran)

1 ♂ *Sulaimaniya, Iraq.*

Wing	bill	tarsus	tail
420	46	74	225

This specimen with two others from Mesopotamia was identified as *ruthenus* Buturlin & Zhitkov by Ticehurst and Buxton (*JBNHS* **28** : 416) and the wing measurements along with the two others were said to be 445, 447, and 465. It was then said to be too big for *nikolskii* but the measurement is either in error or over the curves, and the bird being from the same range of hills as the type locality is probably *nikolskii*.

Some of the feathers on the breast and head show signs of the ' spotting ' against the black shaft streak illustrated by Vaurie 1960, Systematic Notes on Palaearctic Birds No. 41 Strigidae: The genus *Bubo* (*Am. Mus. Nov.* 2000, p. 5).

628 **Bubo nipalensis nipalensis** Hodgson (Nepal) Forest Eagle-Owl 4 : 418

4 : 3 ♂♂ 1* o ? juv.

1* Seethagundy Estate, Nelliampathy Hills; 1 Darjeeling, 1 Chanchang Pani, 1 Cachar.

Wing	Bill	Tarsus	Tail
417, 420 (juv.), 423	48, 50, 51*, 52	62, 64* (3)	200, 220, 228, 245*
(♂♀ 425-470	52-54	60-62	229-250)

The juvenile from south India is strikingly different from the adults.

629 **Bubo nipalensis blighi** Legge (Kandyan Dist., Ceylon) Ceylon Forest Eagle Owl

nil.

630 **Bubo coromandus coromandus** (Latham) (Coromandel Coast) Dusky Horned Owl 4 : 416

7 : 1 ♂ 4 ♀♀ 2 o ? (1 juv.)

1 Larkana, 1 Mirpur Khas, Sind; 1 Kaira, 1 Cambay; 1 Fyzabad, U.P.; 2 no data.

One adult and one male with no data have the upper parts paler than in the other specimens; the former is a little paler than another from Larkana, while the juvenile is creamy white with only the wing, shoulder, and tail showing dark as in the adult.

EL **Bubo africanus milesi** Sharpe (Muscat, Arabia)

1 *Muscat, Arabia.*

631 **Bubo zeylonensis leschenault** (Temminck) (Eastern provinces of India=Chandernagore) Brown Fish Owl 4 : 409

28 : 9 ♂♂ 10 ♀♀ 9 o ? (2 juv., 1 head only).

1 Palampur, Kangra, Punjab; 1 Gwalior, 1 Malwa, 1 Indore; 1 Vagjipur, 1 Nadiad, Gujarat; 1 Kolkaz, Berar; 1 Khandala, Poona; 4 North Kanara; 1 Shembagnur, 3 Palni Range; 1 Chitteri Range, Salem; 1 Balaghat, 2 Chanda, M.P.; 1 Kaira, Bonai, 1 Pithabata, Mayurbhanj, Orissa; 1 Gonda, 1 Faizabad, U.P.; 1 Bankulwa Morang, Nepal; 1 Longview T.E., Darjeeling; 1 South Sylhet, Assam; 1 *Sandoway, Burma.*

	Wing	Bill	Tarsus	Tail
9 ♂♂	380-422 av. 396·6	44-51 av. 49	75-85 av. 79	182-200 av. 189
	(IH 379-443	from skull 49-54	71-90	186-210)
10 ♀♀	371-415 av. 394	50-53 av. 51·5	74-82 av. 78	186-204 av. 193·5
	(IH 392-430	from skull 50-54	71-86	190-207)

There is little difference in size between the sexes. There is considerable variation in the colour of the upper and underparts but it is not possible to isolate any of the differences, either of colour or size. Subspecies *semenowi* Zarudny (Arabistan) and *hardwickii* Gray (Fategarh) which were accepted by Stuart Baker have been dropped in IND. HANDBOOK, the latter being synonymised with *leschenault*. While this appears to be in order, I must mention that among 5 specimens with the Zoological Survey of Pakistan at Karachi from 1 Harnai, Baluchistan, Pakistan (♀ wing 410), 3 Nator, Rajshahi District (2 ♂♂ wing 400, 405, 1 ♀ wing 407), and Chittagong (♀ wing 427), Bangladesh, the first is noticeably paler than the others. Ticehurst (BIRDS OF SIND, *Ibis* 1923, p. 237) refers to a bird from Sind, and another from North West Frontier Province being outstandingly paler than others from India. It will probably be necessary to include *semenowi* Zarudny, type locality Arabistan, in the avifauna of Pakistan.

632 **Bubo zeylonensis zeylonensis** (Gmelin) (Ceylon) Ceylon Brown Fish Owl 4 : 406

1 o? Ceylon. Wing 375 (IH ♂♀ 365-383); bill 46; tarsus 74; tail 174.

Except for slightly shorter tail, Sp. No. 11865 could be included with those from continental India.

633 **Bubo flavipes** (Hodgson) (Nepal) Tawny Fish Owl 4 : 411

1 ♀ Bhuguwda, Nepal, 30 Nov. 1920. Wing 430 (♂♀ 410-455).

— **Ketupa ketupu** (Horsfield) (Java) Malay Fish Owl 4 : 410

According to the FAUNA, Baker found it not very rare in the hills of South Assam and Coltart obtained one in Dibrugarh. It is omitted in SYNOPSIS and IND. HANDBOOK, and Dr. Ripley informs me that there is no specimen of this species from Indian limits at the British Museum and the earlier records need to be confirmed.

634 **Nyctea scandiaca** (Linnaeus) (Lapland) Snowy Owl 4 : 420

nil.

635 **Glaucidium brodiei brodiei** (Burton) (Himalayas, restricted to Simla by Baker) Collared Pygmy Owlet 4 : 450

23 : 12 ♂♂ (2 juv. 1 pull.) 8 ♀♀ (1 rufous, 1 juv. 1 pull.) 3 o?

1 Murree, 1 Dalhousie, 2 Koti State, Punjab; 7 Simla, Himachal Pradesh; 1 Mussoorie, 2 Kumaon, 1 Longview T.E., Darjeeling; 1 Kurseong Division; 1 Bhutan Duars, 1 Laitkynsew, Khasi Hills, 2 Margherita, 1 Etalin, Mishmi Hills, Assam; 2 no data.

	Wing	Bill	Tarsus	Tail
9 ♂♂	84-97 av. 89·4	12-14 av. 13	20-23 av. 22	53-64 av. 58
5 ♀♀	92-96 av. 94·8	12-14 av. 13·6	21-23 av. 21·7	53-63 av. 59
	(IH 88-101	—	21-23	57-66)

Apart from one all-rufous bird (Mishmi Hills), there is considerable variation in the amount of grey or rufous on the upper parts, but as examined by Kinnear (*Ibis* 1937 : 490-1), it is not possible to localize any variety.

The pullet/juveniles differ from the adults in the absence of barring on the wing coverts and spotting/barring on the head. They also lack barring on the breast.

Male Sp. Nos. 12059 and 12060 were both obtained by P.T.L. Dodsworth at Simla on 2nd and 3rd Sept. 1912. The first with a streaked head is marked ' adult ' and the latter with spotted head ' immature ' and a mix up in the labels is suggested.

No specimen (the last collected in May 1949) has the white of the throat suffused with primrose yellow.

636 **Glaucidium radiatum radiatum** (Tickell) (Jungles of Borabhum and Dholbhum) Barred Jungle Owlet **4** : 448

25 : 8 ♂♂ 16 ♀♀ 1 o ?

1 Melghat, Berar ; 1 Dediapada, Rajpipla, 3 Surat Dangs, 1 Navsari, Gujarat ; 1 Bombay ; 3 Manalur, Palni Hills ; 1 Amraoti, 3 Bastar, 1 Kanker, 1 Gondia, 1 Balaghat, 1 Raipur, M.P. ; 1 Jharan, Devkund, 2 Bamra, Orissa ; 1 Gorakhpur, 3 Dehra Dun, U.P.

While *malabaricum* from the southwest is distinctly more rufous than the northern birds, it must be remembered that Blanford included it with *radiatum*. The rufous particularly on the head is most prominent in individuals from Ratnagiri and North Kanara, and then further south into Kerala. Nilgiri birds are said to be nominate *radiatum* and two of the three from the Palnis show no rufous. A third obtained on the same day as one of them is rufous and may well be included with *malabaricum*. The rufous tinge continues northwards and individuals from Kanker, eastern M.P., not far from the type locality, is not very different from others from Khandala, and the neighbourhood of Bombay. Sp. No. 12052 from Dediapada, Rajpipla, Gujarat is very pale-coloured. The measurements are under 637.

637 **Glaucidium radiatum malabaricum** (Blyth) (Malabar Coast and Travancore) Malabar Barred Jungle Owlet **4** : 449

12 : 8 ♂♂ 2 ♀♀ 2 o ?

4 Ratnagiri, Maharashtra ; 5 North Kanara ; 1 Pulayanarkottai, 1 Tenmalai, South Travancore ; 1 no data.

		Wing	Bill	Tarsus	Tail
radiatum	♂♂	127-133 av. 129·5	16-18	25-28	64-70 av. 67
		(IH 124-134	—	22-28	66-80)
malabaricum	♂♂	123-134 av. 128	17-18	24-27	61-67
		(IH 128-135	—	c. 22	65-69)
radiatum	♀♀	126-133 av. 127	16-19 av. 16·8	24-28	59-69 av. 64
		(IH 126-136	—	22-29	63-84)
malabaricum	♀♀	125, 130	18(2)	24, 26	63, 64
		(IH 124-134	—	20-22	62-68)

In the material available, we have no specimen with a tail over 70 mm. contra 80 mm. ♂♂ and 84 mm. ♀♀ in IND. HANDBOOK.

638 **Glaucidium radiatum castanonotum** (Blyth) (Ceylon) Chestnut-backed Barred Owlet 4 : 447

nil.

639 **Glaucidium cuculoides cuculoides** (Vigors) (Simla-Almora district) West Himalayan Barred Owlet 4 : 444

12 : 7 ♂♂ (1 juv.) 1 ♀ 4 o ? (1 juv.)

1 Dalhousie, 1 Dharamsala, Punjab ; 3 Koti State, 2 Simla ; 1 Karuprayag, 1 Kumaon, Garhwal, U.P. ; 1 Gwalior, C.I. (?), 2 Nepal.

	Wing	Bill	Tarsus	Tail
6 ♂♂	140-151 av. 147·2	17-20 av. 18·5	27-31 av. 28	75-83 av. 80
1 ♀	147	20	30	80
3 o ?	145, 153(2)	18(3)	28(2), 30	76, 80, 88
(♂♀	145-162	c. 19-22	24-26	79-90)

There has been considerable difficulty in sorting out the different races, but though examples marked *rufescens*, *brugeli*, *whiteleyi*, *delacouri*, *deignani*, and *austerum* were borrowed from the U. S. National Museum, it has not been possible to straighten out matters, and the differences are referred to under each subspecies. Two birds from Simla and Dalhousie show a slight tinge of rufous, but otherwise agree with the series which is smaller than *rufescens* (q.v.).

Sp. No. 12025 was marked *Glaucidium radiatum*, Gwalior, C.I., collected by C. Maries. We have other specimens marked as collected by Maries at Gwalior or in Kumaon. In the absence of dates and the possibility of their being from the Gwalior Zoo of which he was superintendent, I am for the moment not accepting this as an extension of the known range of the species.

Two juveniles lack the barring on the back which is replaced by pale spots on the head.

640 **Glaucidium cuculoides austerum** Ripley (Tezu, Mishmi Hills) East Himalayan Barred Owlet

2 : 1 ♀ 1 o ?

1 Dibrugarh, 1 Sadiya, U. Assam.

Wing	Bill	Tarsus	Tail
158, 159	19, 20	31, 33	88, 90
(IH ♂♂ 150-154	—	26-29	82-92)
(IH ♀♀ 156-162	—	26-29	86-94)

This subspecies, slightly darker than those under *rufescens*, is either very restricted or represents one end of a cline which, unfortunately, is not very far from the type locality of *rufescens*.

5 specimens from Bhutan, collected by Sálim Ali in 1966/8 but not yet registered, do not agree with any of the other races from India. The

markings on the head are slightly paler and create a distinct cap. The upper parts have a blackish, rather than rufous tint. The lack of rufous on the lower belly is further marked by broad brown streaks with no trace of barring. The general effect, particularly of a ♂ from Gedu (Collector's No. 989, with outer primaries moulting) is that of Blyth's *whiteleyi* (Type locality, China). Another, Col. No. 672 from Tama, 4000′, resembles No. 21776 from Balasun, Darjeeling, which I have left with *rufescens* (q.v.).

Bhutan appears to be the meeting ground of *cuculoides*, *rufescens*, *austerum*, and *whiteleyi*, and it will be necessary to examine a larger series before any definite identifications are made.

641 **Glaucidium cuculoides rufescens** Baker (Manipur) Burmese Barred Owlet **4 : 445**

12 : 4 ♂♂ 5 ♀♀ (1 pull.) 3 o ? (2 pull.)

1 Kewzing, 1 Singtam, Teesta Valley, Sikkim ; 1 Sevoke, 1 Balasun, Darjeeling ; 3 Changchang Pani, 3 Khasi Hills, 2 Cachar, Assam.

	Wing	Bill	Tarsus	Tail
4 ♂♂	146, 152, 153, 155	18(4)	28(2), 30, 33	75, 79(2), 82
4 ♀♀	155(2), 156, 160	19(3), 20	28, 29, 31(2)	82, 85, 89, 95

The two from Sikkim are rufous above and marked *cuculoides* by Ripley, but they cannot be separated from the others in this group either by colour or size. One of the three from Changchang Pani is almost as dark as *austerum*, but the others of the same place are much paler. One ♂ from Balasun Valley, Darjeeling (No. 21776) has less rufous on the head, showing a cap and resembling those from Bhutan referred to under *austerum*. The wing (146 mm.) is smaller than in other *rufescens*. Allowing a very restricted range for *austerum*, it appears that the distribution of *rufescens* as originally indicated by Stuart Baker is the most correct. Two U. S. Nat. Mus. Spp. Nos. 336241 and 336239 from Chingsen Kao and Ban Hong Tan in Siam are marked *rufescens* and *rufescens* > *brugeli* by Deignan, but they are hardly separable from two *brugeli*. It is significant that Deignan only refers to *brugeli* in Birds of Northern Thailand, *Bull. U.S. Nat. Mus.* **186**, 1945.

The three pullets from Khasi Hills were collected by Stuart Baker and marked *Otus spilocephalus*. They are a rich rufous above, unbarred, with numerous buff-coloured spots all over the head.

641a **Glaucidium cuculoides fulvescens** Baker (Kolidoo, Tenasserim) Tenasserim Barred Owlet **4 : 447**

6 : 3 ♂♂ (1 juv.) 1 ♀ 2 o ?

1 Rema T.E., S. Sylhet ; 1 *Ruby Mines*, 1 *N. Shan States*, 1 *Sandoway*, 1 *Kandin*, 1 *Prome Dist., Burma*.

	Wing	Bill	Tarsus	Tail
2 ♂♂	146, 147	18, 19	28, 29	76, 79
2 ♀♀	154, 157	20(2)	29, 30	79, 81
2 o ?	152, 154	19, 20	28, 30	79, 82

Stuart Baker described this at the same time as *rufescens* and these specimens are certainly very distinctly paler, more yellow, and do not agree with others from Siam marked *brugeli/rufescens.* Ticehurst (*JBNHS* **35** : 37-38) refers to two birds from Prome ' resembling *cuculoides* except that they are more rufous on the underparts than most'. This character is true for this group. However, later (*JBNHS* **36** : 935) he states that *fulvescens* from Tenasserim is not separable from *brugeli,* from Bangkok. Incidentally, the type locality of *brugeli,* Bangkok, was corrected to Sam, Khok dist., half way between Bangkok and Ayatthaya by Deignan (Birds of N. Thailand, *Bull. U.S. Nat. Mus.* **186** : p. 179, 1945). As Ayatthaya is about 50 miles north of Bangkok and the change is to an unspecified portion of a district, only half the distance (25 miles) away, this adjustment appears hardly worthwhile. In the north, Deignan (loc. cit.) only accepts *brugeli* though other forms are accepted from the south.

A juvenile ♂ from Ataran, Tenasserim (Sp. No. 12022) is slightly washed with rufous.

The distribution and validity of several races appears confused, and I can only draw attention to the desirability of re-examining the distribution of *rufescens* and the adjoining races, after verifying that the specimens are topotypical.

642 **Ninox scutulata lugubris** (Tickell) (Dampara, Dholbhum, Bengal)
Indian Brown Hawk-Owl **4** : 454

8 : 3 ♂♂ (1 juv.) 5 ♀♀

1 Narwer, Gwalior ; 2 Kolkaz, Berar ; 2 Balaghat, 1 Nainpur, M.P. ; 1 Tirhut, Bihar ; 1 Kumaon, U.P.

A fresh (Oct. 1959) female from Rampur, Bihar, in St. Xavier's High School, Bombay, collection differs in being much greyer above, which presumably fades into brown.

	Wing	Bill	Tarsus	Tail
2 ♂♂	214, 221	21, 22	26, 28	130, 132
	(215-227)	(21-22)	(24)	(124-135)
5 ♀♀	211-216 av. 214	20-23 av. 21	27-28	129-136 av. 133
	(215-227)	(21-22)	(24)	(124-135)

643 **Ninox scutulata burmanica** (Hume) (Pegu and Tenasserim)
Burmese Brown Hawk-Owl **4** : 455

4 ♂♂ 1 Bagho Bahar, Cachar ; 1 Sonapura Sanctuary, Darrang, 1 Changchang Pani, Assam ; 1 *Homalin, Burma.*

	Wing	Bill	Tarsus	Tail
4 ♂♂	212, 215, 216, 220	20, 21, 22(2)	26(4)	130, 132, 134, 144
	(♂♀ 206-222	*c.* 21-22	*c.* 24-25	128-134)

644 **Ninox scutulata hirsuta** (Temminck) (Ceylon) South Indian Brown Hawk-Owl 4 : 457

2 ♂♂

1 Nelliampathy Hills ; 1 Devanhellucutta, Travancore.

These two are darker than *lugubris* from further north. The heads are similar to *burmanica* but the upper parts appear slightly tinged with rufous. The tail tips are not as pure white as in *lugubris*, and this character is shared with *burmanica*.

The wing measurements are larger than indicated in the FAUNA and by Whistler (*JBNHS* **39** : 325), but within the limits quoted in IND. HANDBOOK for *hirsuta*.

	Wing	Bill	Tarsus	Tail
2 ♂♂	212, 213	21, 22	27, 29	124-129
	(188-208 ; IH 190-212)	(about 22)	(*c*. 28 ; IH 24-28)	(112-119 ; IH 112-122)

A female from Belgaum, Mysore, (Oct. 1971) in St. Xavier's High School collection (wing 195, tail 115) is midway between *lugubris* and *hirsuta*, the head being capped and the tail having an indistinct white tip.

645 **Ninox scutulata obscura** Hume (Camorta, Central Nicobars) Hume's Brown Hawk-Owl 4 : 457

4 : 3 ♂♂ 1 ♀.

3 Mannarghat, 1 Goracharama, South Andamans.

In my Andaman and Nicobar reports (*JBNHS* **61** : 535 and **64** : 172), I referred to specimens obtained by Abbott and Kloss at Car Nicobar, Katchal and Little Nicobar as *obscura*. Through the courtesy of the Zoological Survey of India and the Smithsonian Institution, I have been able to get together several *Ninox* obtained in the Andamans and the Nicobars and in a re-examination I notice that, though Richmond (*Proc. U.S. Nat. Mus.* **25** : 304) referred to the Nicobar specimens as *Ninox scutulata*, they are actually *Ninox affinis isolata*, as already marked on the labels by Deignan.

After naming *obscura* from a single specimen from Camorta, Hume described two from South Andamans which differed, he said, from the type in being ' older '. However, there is no evidence of an *obscura* having been collected later from the Nicobars, and it is not possible to follow up the fact that the specimens from the Andamans do not quite agree with the original description.

646 **Ninox affinis affinis** Beavan (Aberdeen Point, Port Blair, Andaman Islands) Andaman Brown Hawk-Owl 4 : 456

nil.

647 **Ninox affinis isolata** Baker (Car Nicobar) Nicobar Brown Hawk-Owl 4 : 456

nil.

As indicated under 645, I have had the opportunity of comparing *Ninox affinis* from South Andamans, Car Nicobar, Little and Great Nicobars. The first a ♂ (ZSI No. 29781 wing 176, tail 100) is noticeably smaller than the others and lacks a white tip to the tail.

The topotype of *isolata* (U.S.N.M. 178462) from Car Nicobar (wrongly quoted as Camorta in FAUNA) is larger (♂ wing 208, tail 125), has more rufous on the upper parts, and very distinct rufous edges to the primary quills.

The two from Little Nicobar (U.S.N.M. ♂ No. 178463, wing 203, tail 122) and Great Nicobar (Z.S.I. ♀ No. 290, wing 195, tail 110) lack the rufous tinge, and have paler bands across the tail. The former has the rufous on the underparts more extensive than in the others, but this may be a variable character. Mr. Bond (personal communication) says that the bird from Katchal, Central Nicobars, (wing 196, tail 120) is identical with that from Little Nicobars, except that the underparts are patterned like the Car Nicobar specimen.

While it is not possible to comment further, I must mention that all the specimens examined appear nearer to *Ninox scutulata* and its several races in India, rather than *obscura* from the Andamans.

648 **Athene noctua bactriana** Blyth (Old Kandahar, Afghanistan)
Hutton's Owlet **4** : 442

(a) 7 : 4 ♂♂ (1 juv.) 2 ♀♀ (1 juv.) 1 o?

1 *Suleimaniyah*, 1 *Shaiba*, *Iraq*; 1 *Mishun*, *Persian Gulf*; 1 *Katunak*, *Shiraz*, 1 *Persepolis*, *Iran*; 1 *Magos*, *Persian Baluchistan*; 1 Surab, Jholawan, Baluchistan.

(b) 7 : 3 ♂♂ 4 o?

1 *Samara*, 1 *Amara*, 3 *Shatt-el-Adhain*, *Iraq*; 1 *Shustar*, *Arabistan*; 1 no data.

Bactriana is accepted as occurring from Afghanistan west to Mesopotamia. Group (a) is distinctly paler than group (b) which (excepting one from Shustar) is all from along the rivers in Mesopotamia, and west of (a). Ticehurst *et al.* (*JBNHS* **28** : 306) state that *bactriana* in spring is noticeably paler than in autumn but the difference cannot be thus explained. The eastern birds are no doubt *bactriana*, but it is not possible to name the others. Within the two groups, there is no variation in the extent of feathering on the toes and the spotting on the breast.

	Wing	Bill	Tarsus	Tail
(a) ♂♀	156-170 av. 163	18-20 av. 18·6	30-32 av. 31·3	81-84 av. 83
(b) ♂♀	158-170 av. 163·3	19-20 av. 19·4	29-32 av. 31·4	81-86 av. 82·8
	(156-168	18-20	*c.* 32	84-87)

The two juveniles have their heads almost unmarked and their breasts also less prominently marked.

649 **Athene noctua ludlowi** Baker (Dochen, 15,000′, Rham Tso Lake, Tibet) Tibet Owlet **4** : 443

nil.

EL **Athene noctua** subsp.

1 ♂ *Muscat, Arabia*. Wing 151, bill 18, tarsus 32.

This is slightly smaller than the others, and has the streaks on the head less prominent. According to Vaurie (*Am. Mus. Nov.* 2015, Fig. 1), this should be *saharae* × *lilith*, but it is darker than *bactriana* (a), which is said to be darker than both.

650 **Athene brama indica** (Franklin) (Banks of the Ganges and in the mountain chain of upper Hindoostan, i.e. Uttar Pradesh) Northern Spotted Owlet **4** : 440

There has been considerable difference of opinion regarding the validity of this race. Blanford (FAUNA **3** : 301) included this with nominate *brama*, but it was elevated to subspecies level by Stuart Baker, who restricted it south of lat. 14° N. Whistler & Kinnear (*JBNHS* **38** : 237) moved this line north to lat. 20°, and Biswas (*Rec. Indian Mus.* 1947, **45** : 261) thought there was no significant difference in size, and that it was impossible to fix a dividing line between the two. IND. HANDBOOK characterises 20° N. as ' arbitrary and for convenience ', and separates them by size and paler upper parts.

The 28 northern specimens (2 juveniles) can be divided into 3 groups :

(a) 11 : 5 ♂♂ 4 ♀♀ 2 o ?

1 *Imam Hasan Gazi, Persian Gulf:* 1 Bampur, 1 Kalat, Baluchistan ; 1 Sararogha, Waziristan ; 1 Khaki, Thar & Parkar, 1 Dadu, Larkana, Sind ; 1 Jajja, Abbasian, Bahawalpur ; 2 Meerut, 1 Kalianpur, Kanpur, U.P. ; 1 Assam.

(b) 8 : 6 ♂♂ (1 juv.) 2 ♀♀ (1 juv.).

2 Ambala, Punjab ; 2 Delhi ; 1 Orissa ; 2 Bihar ; 1 Amaha, Nepal.

(c) 9 : 3 ♂♂ 6 ♀♀

1 Khagori, Kutch ; 1 Gir Forest, 1 Patan, Mehsana, 1 Nadiad, Kaira, 1 Bodeli, Baroda, 1 Sangodh, Navsari, Gujerat ; 1 Kuno, Gwalior ; 1 Gondia, 1 Geedam, Bastar, M.P.

These indicate a slight north-south decline in size, as also a darkening from earthy brown to the dark colour of southern birds.

Group (a) which are the palest consist, however, of the oldest skins, all obtained before 1939. Group (b) has 4 taken between 1921-1925 and one in 1949. In group (c) all are between 1938-1952, with the two westernmost birds (1 Kutch, 1943 ; 1 Gir, Amreli, 1952) palest.

The Zoological Survey of Pakistan, Karachi, have a fair series from Pakistan, and Bangladesh and during the course of a quick examination (January 1971) I noted ' East Pakistan birds appear brown and less grey than those from West.'

651 **Athene brama ultra** Ripley (Chabua, North Lakhimpur District, Northeast Assam) East Assam Spotted Owlet

nil.

652 **Athene brama brama** (Temminck) (Pondicherry and West Coast of India) Southern Spotted Owlet 4 : 439

12 : 5 ♂♂ 6 ♀♀ (1 juv.) 1 o ?

1 Tulsi Lake, 2 Bombay ; 1 Vengurla, 1 Ratnagiri ; 1 Karwar ; 1 Trivandrum, 1 Jamestown, Kanyakumari ; 1 Madura ; 1 Buchireddipalam, Nellore ; 1 Nallamalai Range, Kurnool ; 1 Godaveri Delta.

	Wing	Tail
♂♂	146-155 av. 151·4	70-78 av. 73
	(IH 141-158	66-72)
♀♀	151-155 av. 153·4	70-75 av. 71·5
	(IH 151-157	68-74)

The two oldest skins (1879) are as pale as the northern birds, but this is no doubt due to very appreciable fading from grey to brown. The others show some differences in colour and the darkest are 1929 (1), 1965 and 1969 (2).

The juvenile ♀ from Bombay (1908) is very pale, and has almost no white spotting on the head. The two from Tirhut, Bihar, presumably *indica*, are very similar.

It is possible that the nominate birds have smaller and more numerous speckles on the head. The tail of southern birds is proportionately shorter than the wing, but there is an overlap in size.

EL **Athene brama pulchra** Hume (Pegu) Burmese Spotted Owlet 4 : 440

2 o ? 1 *Shwebo, Upper Burma*, 1 *Mandalay, Burma*. Wing 155, 160.

Stuart Baker states that this is a small dark race but, except for a slight tinge of grey and less prominent white bars on the tail, the present specimens are barely separable from nominate *brama*. The key in the FAUNA requiring a wing under 140 mm. is in error, as he gives the wing range as 143-158.

653 **Athene blewitti** (Hume) (Phuljhar c. 21°N., 83°E., Madhya Pradesh) Forest Spotted Owlet 4 : 441

nil.

654 **Strix butleri** (Hume) (Ormara, Mekran Coast, Southern Baluchistan) Hume's Wood Owl 4 : 404

nil.

655 **Strix ocellata grandis** Koelz (Sasan, Junagadh, Saurashtra) Saurashtra Mottled Wood Owl

Though no specimen from Saurashtra is available, the measurements of the other subspecies do not suggest that the two males (wings 360, 372, and tails 197, 203) on which the subspecies is based are sufficiently larger to warrant separation.

The wing measurements in IND. HANDBOOK **3** : 304 are inconsistent with those given in the key to subspecies.

656 **Strix ocellata grisescens** Koelz [Nichlaul, U.P. (N.E. of Gorakhpur), N. India]

7 : 3 ♂♂ 2 ♀♀ 2 o?

1 Mt. Abu, Rajasthan; 1 Deesa, Palanpur, Gujerat; 2 Darbhanga, Bihar; 1 Bulandshahr, 1 Fyzabad, 1 *col.* F. J. R. Field, March 1892, = U.P.?

The one from Bulandshahr, U.P., is noticeably greyer than peninsular birds, while the others listed above show the same trend. In size, however, they are no larger than southern birds :—

	Wing	Bill	Tarsus	Tail
grisescens				
3 ♂♂	330, 340 (2)	34, 37, 38	56, 58, 59	180, 186, 196
	(IH 338-346)			
2 ♀♀	326, 335	36, 37	57(2)	175, 185
2 o?	340, 360	37, 38	56, 57	185, 195
ocellata				
4 ♂♂	340, 343, 355, 360	36, 37(2), 38	54(2), 56, 58	183, 196, 190(2)
3 ♀♀	332, 335, 342	38, 39(2)	56, 57, 58	176, 188, 190
	(♂♀ 320-345*	36-39	54-56	174-201)
	(IH ♂♀ 333-357*	—	61-65	177-193)

657 **Strix ocellata ocellata** (Lesson) (Pondicherry) Southern Mottled Wood Owl **4** : 402

7 : 4 ♂♂ 3 ♀♀

1 Mahuda Road, Nadiad, 1 Dediapada, Rajpipla, Gujarat; 1 E. Khandesh, 1 Ahmednagar, 1 Ratnagiri; 1 Mundegad, Kanara; 1 Narsampeth, Hyderabad.

Measurements under 656

658 **Strix leptogrammica newarensis** (Hodgson) (Nepal) Himalayan Brown Wood Owl

10 : 1 ♂ 5 ♀♀ (1 pull.) 4 o ? (1 juv.)

2 Bhadarwa (♀ and juv. same date), Jammu, Kashmir; 3 Simla; 1 Mussoorie, 1 pull. Dungari, Garhwal, 1 Naini Tal, U.P.; 1 Terre Bir, 1 Kathmandu, Nepal.

	Wing	Bill	Tarsus	Tail
♂♀	370-450 av. 412	38-45 av. 41·5	53-72 av. 59·5	214-264 av. 235
	(382-412	*c.* 40-45	*c.* 53-56	229-335)

The measurement spreads found by me are much greater than those recorded. Though there is no difference in colour, the size increases greatly westwards, the Jammu ♀ (wing 450, tarsus 72, tail 264) being the largest and the unsexed bird from Kathmandu, Nepal, the smallest (370, 55, 214). The easternmost specimen available being from the type locality, it is impossible to make any comments. In IND. HANDBOOK *newarensis* is said to extend into North and Central Burma, without reference to the validity or otherwise of *shanensis* described by Baker in 1935.

No. 11848 a nestling from Garhwal has pure white head, neck, and underparts. The feathers of the upper parts are however mostly dark brown, only the tips (*c.* 1/3) being white, and hiding the brown. A dark facial disc, as in the adult, is created by similar feathers with shorter or no white tips, the enclosed cheeks being covered mostly with dark bristles, a few feathers showing traces of the barring in adults. The wing and tail are barred.

659 **Strix leptogrammica indranee** Sykes (Lonauli, Western Ghats) Brown Wood Owl 4 : 399

4 : 2 ♂♂ 1 ♀ 1 o?

1 Coonoor, Nilgiris ; 1 Shembaganur, 1 Manalur, 1 Palni Hills.

	Wing	Tail
♂♂	315, 321, ♀ 350, o ? 335	184, 192, —, 183
	(291-348)	(186-195)

660 **Strix leptogrammica connectens** Koelz (Amraoti, Bastar District, eastern M.P.) Dandakaranya Brown Wood Owl

nil.

660a **Strix leptogrammica ochrogenys** (Hume) (Ceylon) Ceylon Brown Wood Owl

nil.

660b **Strix leptogrammica** subsp.

1 o ? Yercaud, Shevaroy Hills, Salem, Tamil Nadu.
Wing 346, bill 41, tarsus 53, tail 217.

Though not very different from *indranee* in size, this specimen is strikingly different in colour, the upper and lower parts containing no trace of rufous, being mostly brown and grey. Similarly, there is no rufous on the facial disc and the lower parts, the latter being more closely barred than in *indranee*. While it does not agree with the description of *connectens*, it is difficult to express an opinion without seeing one, and the type specimen is not traceable.

661 **Strix aluco biddulphi** Scully (Gilgit) Scully's Wood Owl 4 : 397

9 : 2 ♂♂ 5 ♀♀ 2 o?

1 Old Shinghar, 9000′, Baluchistan ; 1 Dungagali, 2 Chitral, N.W.F.P. ; 2 Krew Reserve, 6000′, 1 Sonemarg, Kashmir, 1 Danlong, Kishtwar, 1 Liddar Valley.

	Wing	Bill	Tarsus	Tail
♂♂	312, 321	31, 32	50, 54	200, 205
♀♀	325-334 av. 331	32-37 av. 35	52-55 av. 53	175 mltg.-215 av. 220
(♂♀	285-335	*c.* 33-35	50-51	191-210)

The key in IND. HANDBOOK (3: 310) separating this from *S. a. nivicola* by having the upper plumage ' streaked as well as barred ' against 'not streaked but barred only' is confusing. The barring in adult *nivicola* is hardly visible, but the streaking is absent and would appear to be a sufficient character for their separation.

662 **Strix aluco nivicola** (Blyth) (Himalaya, i.e. Nepal) Himalayan Wood Owl **4** : 311

8 : 4 ♂♂ (2 juv.) 4 ♀♀

1 Keonthal State, 1 *col.* J. A. Anderson, 1885, Himalayas = Simla, 5 Simla, N.W. Himalayas, 1 Mayan Village, Iswa Valley, Nepal.

	Wing	Bill	Tarsus	Tail
♂♂	301, —	32, —	46, —	170, —
♀♀	306, 310(2), 315	32(2), 34, 35	48, 49(3)	173, 176, 182, 190
	(♂♀ 282-312	*c* 22-24	*c*. 45-48	168-175)

There is some variation in colour, but the birds are quite distinct from *biddulphi* in size and colour. Of the two juveniles, both from Simla, one is a little more rufous than the other, while both show more signs of barring on the upper parts than the adults.

Two males, one from Iswa Valley and one, yet unregistered, from Bhutan, have wing 297, 296, bill 28, 31, tarsus 46, 48, and tail 172, 174. In addition to their slightly smaller size, they are much darker, almost black, above and more rufous below. The second is probably the Bhutan specimen whose measurements are detailed in IND. HANDBOOK (**3** : 312). Among the differences, the 62 mm. tarsus is certainly in error.

The bill measurements in FAUNA, quoted in IND. HANDBOOK, are much smaller than those for *biddulphi*. My measurements do not confirm this difference, and it is suggested that the bills were not measured from the feathers of the forehead, but from where the bristles from the sides meet over the bill !

EL **Strix seloputo seloputo** Horsfield (Java) Malayan Wood Owl **4** : 403

1 ♀ *King Island* (*off Tenasserim*).

Wing 350 (347-376) ; bill 40 (43-45) ; tarsus 59 (59-60) ; tail 190 (188-198).

663 **Asio otus otus** (Linnaeus) (Sweden) Longeared Owl **4** : 393

7 : 3 ♂♂ 3 ♀♀ 1 o ?

1 *Nasiriyeh, Euphrates*, 1 *Lagait, Mesopotamia* ; 1 *Shiraz*, 1 *Abid, S. Persia* ; 1 *Maimawak* (? *Maimana, Afghanistan*) ; 1 *Saprudam, confluence of Adung* and *Seinghku, N. Burma* ; 1 *Peking, China*.

	Wing	Bill	Tarsus	Tail
♂♂	294, 295, 310*	25, 25, 26	35, 37, 38	136, 139,—
♀♀	290, 293, 295	26, 26, 28	36, 37, 38	136, 140, 154
	(285-305	28-29	*c*. 40	140-155)

* IND. HANDBOOK quotes Hartert : 'rarely 310'.

664 **Asio flammeus flammeus** (Pontoppidan) (Sweden) Shorteared Owl 4 : 394

26 : 8 ♂♂ 13 ♀♀ 5 o ? (*2 heads only)

1 *Sulaimaniya*, 2 *Kut*, 1 *Qualet Saleh*, *Mesopotamia* ; 1 *Randha Tanhat*, *Yemen*, *Arabia* ; 1 *Kaftarak*, *Shiraz* ; 1 Bahadurchah, near Sib, 1 Korak, Kalat, 1 Fort Sandeman, Baluchistan ; 1 Dalipota, Hyderabad, 1 Khahi, Thar Parkar, Sind ; 1 Ambala, Punjab, 1 Bhimnal, Jodhpur, 1 Mandvi Dunes, Kutch, 1 Asimali, Kaira, 1 Dabka, Baroda ; 1 Nasik, 2 Bombay ; 1 Meerut, 2* Gonda, U.P. ; 1 Calcutta Market ; 2 Monai, Goalpara, Assam ; 1 *Henzada, Lower Burma*.

	Wing	Bill	Tarsus	Tail
8 ♂♂	300-312 av. 305·5	*c*. 26	38-44 av. 40	140-150 av. 143
13 ♀♀	300-321 av. 311·8	26-28 av. 27	38-46 av. 41·4	140-147 av. 143·8
	(IH ♂♀ 290-325	—	43-48	139-150)

In Sp. No. 11816 from Goalpara, Assam, one of the two differently coloured central tail-feathers projects 28 mm. beyond the rest of the tail which is normal (144 mm.).

665 **Aegolius funereus funereus** (Linnaeus) (Sweden) Tengmalm's Owl

nil.

666 **Batrachostomus moniliger** Blyth (Ceylon) Ceylon Frogmouth 4 : 381

4 : 3 ♂♂ 1 ♀

1 Santgal, 1 N. Kanara ; 1 Thattakad, N. Travancore ; 1 Ceylon.

	♂♂	♀
Wing	119, 121, 122	123
	(IH ♀♂ 119-127)	
Tail	102, 109, —	105
	(IH ♂♀ 100-110)	

All the three males show differences in colour.

667 **Batrachostomus hodgsoni hodgsoni** (G. R. Gray) (Darjeeling) Hodgson's Frogmouth 4 : 378

nil.

668 **Eurostopodus macrotis cerviniceps** (Gould) (Trang, Peninsular Siam) Burmese Great Eared Nightjar 4 : 374

2 : 1 ♂* 1 o ?

1* Golaghat, Assam ; 1 *Bankachon, S. Tenasserim*.

Wing	Bill	Tarsus	Tail
300, 315*	11·5*, 12	17*, 21	198, 215*
(292-317	*c*. 10-11	21-22	207-225)

The male from Assam has a slight rufous wash all over the upperparts, which are greyish in the other.

669 **Eurostopodus macrotis bourdilloni** (Hume) (Kalland, Khaumi, Travancore) Bourdillon's or Kerala Great Eared Nightjar 4 : 375

1 ♂ Tenmalai, C. Travancore.
Wing 278, bill 10, tarsus 15, tail 190.

670 **Caprimulgus indicus hazarae** Whistler & Kinnear (Abbottabad, Hazara, Himalayas) Himalayan Jungle Nightjar

11 : 7 ♂♂ 4 ♀♀.
2 Koti State, 3 Simla ; 2 Garhwal, 1 Ranibagh, Kumaon ; 3 Changchang Pani, Assam.

	Wing	Bill	Tarsus	Tail
♂♂	198-206 av. 203	11-12	15-17 av. 15·5	120-143 av. 132
	(IH 200-215 ; Vaurie 196-213 av. 205·9	—	—	124-146)
♀♀	200, 203, 207, 214			
	(IH 189-203 ; Vaurie 195-206 av. 201		—	128-137)

Except for ♀ Sp. No. 18946 from Simla, 7000′, obtained on 19 Sept. 1927, with a 214 mm. wing and the second primary longer than the third, the wings are smaller than generally accepted. The overall colour of this specimen is however very rufous and does not agree with La Touche's statement that female *jotaka* are very grey ; so I am leaving it with *hazarae.* Seven of the 12 available have their second primary longer than the third and *contra* Mayr (*Ibis* 1938, p. 311) this does not appear to be consistent for *hazarae.*

671 **Caprimulgus indicus indicus** Latham (India) Indian Jungle Nightjar 4 : 366

19 : 9 ♂♂ 10 ♀♀ (2 by plumage)
1 Saiat, 1 Nadiad, Kaira, 1 Surat Dangs ; 1 Bassein, Bombay ; 2 Khandala ; 1 Chauk, Kolaba ; 1 Mahableshwar ; 1 Chaurakund, Amraoti, Berar ; 3 N. Kanara ; 1 Peermade, 2 Merchiston (Ponmudi), S. Travancore ; 1 Sankarametta, Vizagapatam Ghats ; 2 Balaghat, M.P. ; 1 Diviri Bund, Orissa.

	Wing	Bill	Tarsus	Tail
♂♂	176-200 av. 187	10-13 av. 11·3	15-17 av. 15·6	119-135 av. 126
	(IH 174-198	20-24 from skull	15-18	125-144)
♀♀	175-201 av. 184	10-12 av. 11	14-16 av. 15·4	115-129 av. 124
	(IH 181-195	—	—	124-135)

There is some variation in the extent of the markings and the general colour. This subspecies is smaller and greyer than *hazarae.*

672 **Caprimulgus indicus kelaarti** Blyth (Ceylon) Ceylon Jungle Nightjar 4 : 368

nil.

672a **Caprimulgus indicus jotaka** Temm. & Schl. (Japan) Migratory Nightjar **4** : 367

1 ♂ lat. 12°34′ 30″ N. ; long. 93° 38′ 30″E., *c.* 60 miles north-east of Port Blair.

	Wing	Bill	Tarsus	Tail
1 ♂	213	11·5	14	130
(Vaurie	♂♂ 208-218 av. 215			
	♀♀ 203-217 av. 210)			

673 **Caprimulgus europaeus unwini** Hume (Agrore Valley and in the neighbourhood of Abbottabad) Hume's European Nightjar **4** : 359

12 : 3 ♂♂ (1 juv.) 4 ♀♀ 5 o ?

1 *Shatt-el-Adhain, Mesopotamia* ; 1 *Aden, Arabia* ; 1 Chatuki, 60 m. ENE. of Panjgur, 1 Hazarganj, 1 Mastung, Baluchistan ; 1 Wana, Waziristan ; 1 Karachi ; 1 Bahawalpur, Punjab ; 1 Bhachau, 2 Rapar, Kutch ; 1 Bombay City.

	Wing	Bill	Tarsus	Tail
unwini 3 ♂♂ (1 juv.)	179, 180, 182	9, 10, 10·5	14, 15(2)	122, 125, 139
[IH ♂♀	172-192	*c.* 9-10	*c.* 16-17	(117) 125-144]
sarudnyi ? 2 ♂♂	185, 197	9, 10	14, 15	133, 135
unwini 4 ♀♀	180, 182, 186, 189	9, 10(2), 11	12, 15(2), 17.5	126(2), 128 (2)
sarudnyi ? 3 ♀♀	185, 187, 191	10(2), 11	16(2), 17	126, 132, 135

The unsexed (female by plumage) *sarudnyi* from Jalander Bet, has a 162 mm. wing.

673a **Caprimulgus europaeus sarudnyi** Hartert (Tarbagatai Mountains)

6 : 2 ♂♂ 3 ♀♀ 1 o ?

1 *Shaiba*, 1 *Baghdad, Mesopotamia* ; 1 *Akbarabad* 52°47′E., 29°13′N., *Persia* ; 1 Sakesar, 1 Pail, Salt Range, Shahpur Dist., Punjab, 1 Jalander Bet, Kutch.

All these are slightly darker above than *unwini* but not so dark as the illustrations of nominate *europaeus* in HANDBOOK OF BRITISH BIRDS (Vol. **2**, pl. 53).

The two adult males (1 Shaiba, 1 Sakesar, Shahpur Dist., Punjab) do not show the white spots on outer webs of the first, second, and third primaries as clearly as in *unwini* ; the first has been named *sarudnyi* by Ticehurst (*JBNHS* **28** : 299). Accepting *sarudnyi* as synonymous with nominate *europaeus*, the Indian specimens included above (obtained on 6 May, 15 August, and ? September) would add a new bird to the Indian list. The absence of any topotypical specimens of nominate *europaeus* and the difference in the illustrations referred to above suggest a closer examination. If *sarudnyi* were synonymised with *unwini*, the specimens could well be included therewith as individual variation therein.

Both (?) subspecies which are very similar to *C. indicus* in colour can be separated by the first primary being equal to or usually longer than the third, against its being shorter than the third in *indicus*.

674 **Caprimulgus mahrattensis** Sykes (Mahrattas ?) Sykes's or Sind Nightjar **4** : 369

17 : 11 ♂♂ (1 juv.) 5 ♀♀ 1 o ?

1 Jami, 24 m. E. of Turbat ; 1 Tapk, Gish Naur, 20 m. W. of Bubha, Baluchistan ; 1 Bhaganwala, Jhelum Dt., 1 Larkhana ; 1 Pithoro, Sind ; 1 Bahawalpur ; 1 Bharatpur, Rajasthan ; 1 Kharirohar, 1 Charwa, Bhuj, Kutch ; 1 Bhavnagar ; 1 Mehmedabad, 4 Kaira ; 1 Dabka, Baroda, Gujarat ; 1 Kalyan, Maharashtra.

	Wing	Bill	Tarsus	Tail
♂♂	164-178 av. 171·6	8·5-10 av. 9	19-21 av. 20·3	100-107 av. 103
♀♀	161-168 av. 163·5	9-10 av. 9	20-21	100-107 av. 102·5
	(IH ♂♀ 157-173	from skull *c.* 18-20	*c.* 18-22	100-104)

Two specimens (Nos. 11717 and 11719) marked female have pure white tips to the outer tail feathers. The juvenile male from Kutch extends the accepted breeding range of this species southwards (*JBNHS* **68** : 452).

675 **Caprimulgus macrurus albonotatus** Tickell (Dampara, Dholbhum, Bengal) Indian Longtailed Nightjar **4** : 364

16 : 10 ♂♂ 5 ♀♀ 1 o ?

These birds fall into three groups :—

(a) *Palest.* 8 : 4 ♂♂ 4 ♀♀

1 Gama-Ki-Hatti (5000′), Dharni State, 1 Salugra, 2 Jabli, Bhagat State, 1 Mathola, Patiala, 1 Kalka ; 2 Mussorie.

The four females are much paler than the males, which are not so distinct from those under group (c).

(b) *Rufous.* 6 : 4 ♂♂ 1 ♀ 1 o ? (juv.)

1 Bankulwa Morang, Nepal ; 2 Calcutta Market, 1 Rajabhatkawa, Jalpaiguri, Bengal ; 1 Anantgiri 3000′, 1* juv. Lamasingi, 2500′ Vizagapatam Ghats.

Both sexes are tinged with rufous above and below, the latter character shared with *ambiguus* from Darjeeling. The specimen from Anantgiri, obtained by La Personne during the Eastern Ghats Survey, is so far as I can ascertain the only adult obtained in peninsular India. It is quite distinct from *atripennis* (q.v.) and I cannot understand the statement in IND. HANDBOOK (**4** : 17) that the population of the Eastern Ghats is 'largely intermediate with the southern'.

*The juvenile, like the adult from the same area, is very rufous.

(c) Intermediate between (a) and *ambiguus* 2 ♂♂

2 Sarda R., Kheri, U.P.

I have also seen 2 ♂♂ and 1 ♀ from Rampur, Bihar, in the St. Xavier's High School collection which agree with these.

As the three groups show no differences in size, their measurements are placed together :—

	Wing	Bill	Tarsus	Tail
10 ♂♂	201-220 av. 215	10-12 av. 10·4	17-19	155-175 av. 165
5 ♀♀	201-213 av. 208	10-11 av. 10·8	17-18	159-171 av. 166
	(IH ♂♀ 207-228	—	19-21	146-179)

676 **Caprimulgus macrurus atripennis** Jerdon (Eastern Ghats to west of Nellore) Jerdon's or Southern Longtailed Nightjar 4 : 361

5 : 3 ♂♂ 1 ♀ 1 o?
2 Santgal, 1 N. Kanara ; 1 Pt. Calimere ; 1 Berbera, Puri Dist., Orissa.

	Wing	Bill	Tarsus	Tail
4 ♂♀	174, 185(2), 187	10, 11(2), 12	18, 19 20(2)	128, 130, 133, 136
	(IH 170-189		16-19	124-133)

A single male from Berbera, Puri District, Orissa, agrees well in size and colour with *atripennis* from the south and it would appear that, in the low country, *atripennis* extends north of the southern limit of *albonotatus* along the ghats.

The 4 adults have a very distinct collar of rich rufous, which is lacking in a juvenile male with growing tail and wing quills, netted at Point Calimere on 26 January 1970 by the bird migration camp.

677 **Caprimulgus macrurus aequabilis** Ripley (Trincomalee, NE. Ceylon) Ceylon Longtailed Nightjar

nil.

678 **Caprimulgus macrurus ambiguus** Hartert (Malay Peninsula, Burma, Assam, and the eastern Himalayas. Restricted to southern Tenasserim) Burmese Longtailed Nightjar 4 : 363

2 ♂♂ : 1 Darjeeling, Bengal ; 1 Dimapur Road, Manipur State, Assam.

Wing	Bill	Tarsus	Tail
206, 207	10, 11	17, 18	157, 164
(♂♀ 195-223	9-10	*c.* 19-20	168-181)

679 **Caprimulgus macrurus andamanicus** Hume (Jolly Boys Island, Andaman Islands) Andaman Longtailed Nightjar 4 : 363

6 : 2 ♂♂ 4 ♀♀
1 Long Island, 1 Betapur, Middle Andamans ; 2 Wrightmyo, 2 Port Blair, South Andamans.

The four females are slightly paler than the males, with the two non-breeding birds, both February, paler than the other two in April.

	Wing	Bill	Tarsus	Tail
2 ♂♂	180, 184	10, 11	17, 17	122, 130
4 ♀♀	175, 180, 182, 185	10(3), 11	17(3)	125(2), 127, 135
	(♂♀ 172-186	*c.* 10-11	16-17	125-130)

680 **Caprimulgus asiaticus asiaticus** Latham (India=Bombay) Indian Little Nightjar 4 : 372

33 : 20 ♂♂ (1 juv.) 11 ♀♀ 2 o?

Specimen No. 11742 from Ratnagiri, Maharashtra, is missing. The remaining birds fall into 3 colour groups :

(a) Pale. 13 : 4 ♂♂ 9 ♀♀

1 Jagadhri, Ambala, Punjab ; 2 Bombay City, 1 Ratnagiri, 1 Goa ; 2 Bangalore, 1 Mysore, 1 Mananur, Hyderabad ; 1 Baramba, Orissa ; 1 Baghowni, Tirhut, Bihar ; 1 Calcutta Market ; 1 *Okama* (?), *West Bank, Chindwin.*

(b) Grey, 13 : 9 ♂♂ (1 juv.) 3 ♀♀ 1 o?

2 Bhuj, Kutch ; 1 Bhavnagar, 1 Kaira, Gujarat, 3 Thana, 2 Bombay City ; 1 Kailas, 1 Mirkher, Hyderabad ; 1 *Ngaphaw, Prome,* 1 *Teingue, Henzada, Burma.*

(c) Dark. 6 ♂♂

1 Kalyan, 1 Bombay ; 1 North Kanara ; 1 Barkot, Bamra, 1 Bhanuprattappur, Kanker, 1 Gondia, C.P.

It is noticeable that all the six dark birds are males ; they were obtained in December (4), January, and February. The birds from Andheri, Bombay, and Kanker, C.P., both December, were marked ' excessively fat '.

681 **Caprimulgus asiaticus eidos** Peters (Vavuniya, Northern Ceylon) Ceylon Little Nightjar

nil.

682 **Caprimulgus affinis monticolus** Franklin (Ganges between Calcutta and Benares) Franklin's or Allied Nightjar 4 : 370

28 : 15 ♂♂ 12 ♀♀ 1 o?

1 Chaklala, Rawalpindi ; 3 Bhagat State, Simla Hills ; 1 Madhopur, Punjab ; 1 Bharatpur, Rajasthan ; 1 Narwar Fort, Gwalior ; 2 Bhavnagar, 1 Libari, Kaira, 1 Jambghoda, Gujarat ; 1 Raipur, Melghat ; 1 Padgha, Thana, 1 Khandala, 1 Pen, Kolaba, 2 Ratnagiri, Maharashtra ; 1 Naiti, N. Kanara ; 1 Vandiperiyar, Travancore ; 2 Jabalpore, 2 Supkar, Balaghat 1 Seoni, Malwa ; 1 Daspalla, Orissa, 1 Calcutta Market ; 2 Rema Tea Estate, Sylhet.

The females are slightly paler than the males. Both sexes show differences in extent of markings and depth of colour. Only one male (No. 18952, Jabalpore, C.P., 18 Feb. 1934) has a rufous collar. A juvenile ♂ (No 18953, Bhagat State, Simla Hills, wing 184) has whitish spots on the primaries but the tail as in the female. The upper parts are paler and lack the markings of the adult.

	Wing	Bill	Tarsus	Tail
14 ♂♂	188-210 av. 196·5 (IH 181-205,	9-11	17-19 (IH ♂♀ 18-21	110-130 av. 120 108-124)
12 ♀♀	179-195 av. 188 (IH 179-202)	8-11	17-19	105-119 av. 112·5

682a **Caprimulgus aegyptius aegyptius** Lichtenstein (Upper Egypt) Egyptian Nightjar

4 : 1 ♂ 1 ♀ 2 o?

2 *Shaiba*, 1 *Basra*, 1 *Baghdad*, *Mesopotamia*.

Wing	Bill	Tarsus	Tail
202(3), 203	9(2), 10(2)	20, 21(2), 22	128, 130

The upper and lower plumage is remarkably similar to that of *Caprimulgus maharattensis* Sykes though the white markings on the primaries are distinctive. This species has been recorded from Baluchistan (*JBNHS* **43** : 483; see also *JBNHS*).

(*to be continued*)

A new fish of the Family Gobiidae from Godavari Estuary

BY

V. VISWESWARA RAO[1]

(*With a text-figure*)

Godavari estuary, especially the lower reaches with a net work of shallow creeks and dense mangrove vegetation offers a less disturbed habitat mostly favoured among other fishes by a number of gobioids. A detailed account of the Godavari estuarine gobioids belonging to the subfamily Gobiinae has been published elsewhere (Visweswara Rao 1971). This paper describes a new species belonging to the genus *Waitea* Jordan & Seale from the Godavary estuary.

Waitea buchanani sp. nov.

(Text-fig. 1)

Holotype : Total length 72 mm (Standard length 56 mm), from Godavari estuary; deposited in the Zoology Museum, Andhra University, Waltair.

Description : Based on the holotype.

D_1 6 : D_2 1+10 ; A 1+9 ; P 17 ; C 14 ; L.l 46 ; L. tr. 14 ; Predorsal scales 14 ; GR 3.1.10.

Body elongated, cylindrical anteriorly, compressed posteriorly. Depth 5·8 in total and 4·2 in standard lengths. Head 4·0 in total and 3·0 in standard lengths, slightly depressed behind eyes. Eye 3·5 in head, prominent above dorsal profile, bony interorbital narrow. Snout almost same as eye. Mouth oblique, lips moderate, lower jaw prominent, the gape extends to below middle of eye. Maxilla modified into an expanded spade-like bone, enclosed in a thin membraneous sheath, projects freely behind corner of mouth to preopercular margin. Nostrils simple pores. Many rows of sharp teeth in both jaws ; in upper jaw an outer row of widely placed large, curved, caniniform teeth, four in front larger ; lower jaw with slightly enlarged teeth in outer row with a strong canine at either end. Teeth in upper jaw extend to corners of mouth, those in lower jaw do not extend so far. Palate edentulous, the vomerine bones crenulated, project prominently below roof of mouth covered by tough membrane. Tongue rounded. One pore behind eye, two in the well formed supra-opercular groove, one in the margin of preopercle. Some sensory canals on top of head behind eyes and on cheeks. Gill openings well forward below, to middle of preopercle. Gill rakers 3.1.10.

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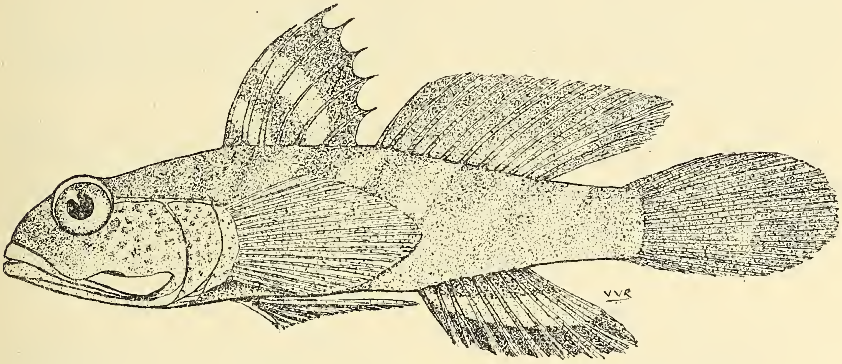

Fig. 1. *Waitea buchanani* sp. nov., type, 72 mm. total length. Note the projection of spade-like maxilla beyond corner of mouth.

First dorsal above pectoral base, slightly behind gill openings, spines flexible, 2nd and 3rd longest, base 1·8, height 1·3 in head. Second dorsal origin $\frac{1}{3}$ eye length behind 1st dorsal, almost midway between hind margin of orbit and caudal base, rays increase in length posteriorly, base 1·2, height 1·3 in head. Anal from below 3rd to 9th rays of soft dorsal, base 1·8, height 1·6 in head, rays increase in length posteriorly, the 1st less than half in the longest ray. Pectoral obtuse, no free rays, a little more than $\frac{3}{4}$ in head length. Ventral slightly shorter than pectoral, oval. basal membrane well developed. Caudal oblong, slightly shorter than head.

Scales on body become strongly ctenoid and larger in line behind middle of pectoral to second dorsal origin and anal origin, cycloid scales in front. About 14 rows of small cycloid scales on nape before dorsal fin extend to above preopercle. Few cycloid scales on base of caudal fin. No scales on top of head behind eyes, cheeks and pectoral base ; breast scaly.

Head and body muddy brown, the former a little darker, large brown blotches on preopercle, opercle and pectoral base. Eight broad transverse bands on body, two from nape to opercle, two below 1st dorsal base, three below 2nd dorsal base and one before caudal base ; from third band they become gradually broader and oblique posteriorly, merging somewhat with the ground colour in the lower third of body. First dorsal dark brown with two transverse lighter bands, anal dark brown with a broad lighter band along its middle, second dorsal, caudal and ventral darker.

Remarks : The maxillary bone is prolonged behind eye to varying lengths in some genera of Gobiinae (Day 1878, 1889 ; Koumans 1941, 1953 ; Smith 1959, 1960 ; Visweswara Rao 1971). The new species falls within the genus *Waitea* in having caudal fin shorter than head, many rows of teeth in both jaws, well developed pelvic freanum, gill openings to below preopercle, round tongue and maxilla prolonged to margin of preopercle.

There is a striking resemblance between the new species and *W. duque* (Smith) (Smith 1959). Both have the same number of dorsal and anal fin rays, gill opening half way to eye, rakers well developed, brown bands on body and first dorsal with two lighter bands.

The differences listed below clearly separate the two species.

	W. duque	*W. buchanani*
1.	Predorsal scales 2-3, none before gill openings.	Predorsal scales 14, scales before gill openings to front of preopercle.
2.	Eye 5 in head.	Eye 3·5 in head.
3.	First dorsal attached a little above base to second dorsal (from figure).	First dorsal well separated from second dorsal.
4.	First dorsal spine longest, about twice body depth.	First dorsal spine shorter than second, second and third dorsal spines longest, less than depth.
5.	Small curved canines in front in each jaw.	Upper jaw with an outer row of widely placed large, curved, caniniform teeth, four in front larger ; lower jaw with a slightly enlarged outer row of teeth with a strong canine at either end.
6.	Gill rakers 4.1.13.	Gill rakers 3.1.10.

Apart from the above differences the new species also differs in coloration, having a broad lighter band along the middle of dark anal fin, two broad bands from nape to above opercle and in the presence of a spade-like maxilla which projects out freely behind the corner of mouth. The number of scales along lateral line in the new species (46) is less than that of *W. duque* (50) and more than that of *W. mystacina* (Val.) (37), the only other species belonging to the genus.

The new species is named after Hamilton Buchanan who contributed much to the knowledge of Indian fish fauna.

ACKNOWLEDGEMENTS

I am grateful to Professor P. N. Ganapati for facilities and to I.C.A.R. for financial assistance.

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A new Genus and Species of Fish from India

BY

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(*With a text-figure*)

While studying the fishes of Khasi Hills (India) in the collection of Eastern Regional Station of the Zoological Survey of India, I came across some remarkable specimens of a little eel-like fish which on detailed examination proved to be of a new genus. The new genus belongs to the suborder Mastacembeloidei (Greenwood, Rosen, Weitzman and Myers 1966) of the order Perciformes but is not being placed in any family since its relationship with other members of the suborder is still under active study. All the specimens of this new genus which is named in honour of Dr. R. S. Pillai of this station, have been collected by bag net from edges of streams amidst dense overhanging vegetation at altitudes ranging from 3,500 ft. (1066·8 metres) to 5,000 ft. (1524·0 metres).

Pillaia gen. nov.

Small eel-like fish with long anteriorly depressed head ; without spines before dorsal or anal or anywhere else on the body ; with both dorsal and anal united with the caudal of 8-10 unbranched rays ; without scales ; lateral line clearly discernible on the head, and less distinct on the body ; branchiostegals 6 ; a rather indistinct fleshy rostral appendage bearing anterior tubular nostrils ; eyes fairly prominent, placed dorsally ; gill-openings wide, extending dorsally to the level of pectoral origin ; gill-membranes free from each other and from isthmus ; mouth wide and horizontal ; teeth on jaws arranged in narrow bands, small, sharply pointed and curved inwards ; pectorals small ; ventrals absent.

Monotypic : type *Pillaia indica* sp. nov.

Pillaia indica sp. nov.

B. VI. D. 34-36. A. 34-36. C. 8-10. P. 7-9.

Depth of body 7·36 to 9·39, length of head 15·0 to 17·40, snout to dorsal origin 58·75 to 61·10, length of caudal 6·94 to 9·92, length of pectoral 1·35 to 2·24 in % of standard length. Snout 25·00 to 28·00, eye-diameter 7.28 to 8·34, interorbital distance 7·69 to 9·10, post-orbital head length 61.50 to 66·60 in % of head length.

Body colour (in spirit) variable, upper part of body light to dark purplish brown, the lower part yellowish or very light brown ; fins dirty white ; series of open Vs of dark colour and dark lines on either side of the body (Fig. 1).

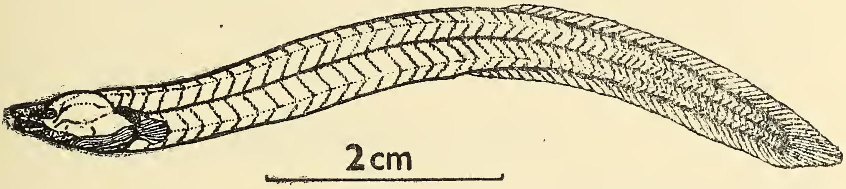

Fig. 1. *Pillaia indica* gen. et. sp. nov. Holotype

In a specimen of about 70·0 mm., ripe ovaries containing large (1.0 mm.) subspherical ova were found. The gut contents included parts of mayfly (Ephemeroptera) naiads, parts of other insects and spores.

Type-specimens: All the type-speciemens temporarily kept at this Station will be ultimately deposited in the Zoological Survey of India, Calcutta.

Holotype : Reg. No. V/ERS 456, total length 77·0 mm, from Sumer stream, *c.* 22 Km. N. of Shillong, Khasi & Jaintia Hills (Meghalaya), India, coll. R. K. Varshney, 24th November, 1967, altitude 1068·80 metres.

Paratypes : Four specimens, out of which two, Reg. Nos. V/ERS 457-458, total lengths 37·0 & 40·0 mm., with the same data as that of holotype ; one Reg. No. V/ERS 459, total length 72.0 mm., from a stream at Umshing, *c.* 13 Km. N. of Shillong, coll. M. Rynth, 13th August, 1963, altitude 1,524 metres ; one Reg. No. V/ERS 460, total length 41·0 mm., from the same locality as that of holotype, coll. R. S. Pillai, 6th February, 1971.

ACKNOWLEDGEMENTS

I thank Dr. A. P. Kapur, Director, Drs. A. G. K. Menon and R. S. Pillai, Superintending Zoologists, Zoological Survey of India for their encouragement and advice and Dr. P. H. Greenwood, British Museum (N. H.) for useful suggestions.

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On a new Species of Anchovy of the genus *Coilia* Gray, 1831

BY

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(*With a text-figure*)

INTRODUCTION

The recent work of Whitehead (1966, 1967) and Whitehead *et al.* (1966) has helped to remove the confusion in regard to the identification of most species of *Coilia* Gray, 1831. The key of Whitehead (1967b) is particularly useful. During investigations on the clupeoids of Andhra Coast, we have come across a new species of *Coilia*, which does not fit in the above key and is described below.

MATERIAL AND METHODS

Fishes belonging to the genus *Coilia* were collected from shore seine catches near Gollapalem, (Krishna District, Andhra Pradesh) during 1966-70. In taking linear measurements, total length was measured from tip of snout to longest caudal ray; standard length from tip of snout to mid-base of caudal fin ; head length from tip of snout to hindmost point on operculum ; depth is maximum depth.

Coilia korua sp. nov.

(Text-figure)

Holotype and paratypes chosen from batch (*c*) are described below. All of them are deposited in the Museum, Department of Zoology, A.U. Post-graduate Centre, Guntur-5.

Material Examined :

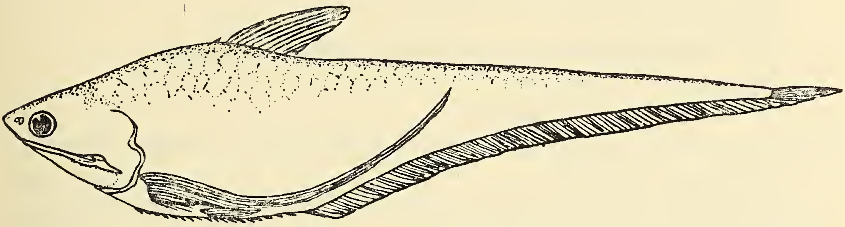
- (*a*) 1 fish, 110 mm S.L. (11-xii-1966).
- (*b*) 2 fishes, 106-116 mm S.L. (26-xi-1967).
- (*c*) 15 fishes, 105-121 mm S.L. (17-xii-1967).
  - 1 fish 120 mm S.L., Holotype of species.
  - 5 fishes 105-121 mm S.L., Paratypes of species.

Description :

Holotype : In the Museum, Dept. of Zoology, A.U. Post-graduate Centre, Guntur ; 120 mm S.L. (132 mm tot. 1)., Gollapalem, Krishna District, Andhra Pradesh ; 17-xii-1967.

Paratypes, 5 fishes, 105-121 mm. S.L. (116-133 mm. tot. 1), taken along with the holotype and bearing the same data.

Br. St. 10 (10-11), D I 12 (I 12), P xii+7 (xii-xiii+5-7), V i 6 (i 5-6), A 101 (101-106), G.R. 24+30 (23-26+30-33), Scutes 8+10 (7-9+9-11, total 17-19).



Coilia korua sp. nov., holotype, 132·0 mm. tot. 1., Gollapalem.

In percentages of standard length : total length 111.6 (109·1-111·6) ; body depth 20·8 (20·0-20·9) ; head length 18·3 (17·0-18·3) ; snout length 4·1 (3·6-4·5) ; eye diameter 4·1 (4·1-4·7) ; maxilla length 13·3 (12·5-14·2) ; pectoral fin length (longest filament) 45·8 (40·0-46·6) ; pelvic fin length 9·1 (8·1-9·1) ; pre-dorsal distance 29·1 (26·6-29·1) ; pre-pelvic distance 24·1 (22·7-24·7) ; pre-anal distance 36·6 (36·6-38·1).

Body compressed, depth slightly greater than head length, deepest below dorsal origin, tapering gradually to tail. Belly slightly convex, compressed and keeled from below pectoral origin to vent. Snout produced, equal to eye diameter. Lower jaw slender, with a series of small conical teeth and with prominent knob at dentary symphysis. Maxilla does not reach gill opening; a series of fine teeth on premaxillae and along lower edge of maxillae. Two supra-maxillae, the anterior (first) delicate, nearly triangular and the posterior (second) slender anteriorly and expanding posteriorly, the anterior portion being hidden behind maxilla, when viewed from outer side.

Gill rakers slender, equal to eye diameter and twice length of corresponding gill filaments. Muscular portion of isthmus reaching forward to hind margin of branchiostegal membrane.

Scutes sharply keeled, beginning below pectoral origin.

Dorsal fin preceded by small scute-like spine. Distance from snout tip to dorsal origin less than four times in total length. Pectoral with 12-13 free filaments, the longest reaching to pelvic base. Pelvic less than postorbital length of head, its origin before dorsal origin, nearer o pectoral base than to anal origin, equal to dorsal-anal inter-space (linear). Anal origin behind vertical from last dorsal ray by one eye diameter.

Colour :

Dorsal side greenish, flanks golden yellow, abdomen and ventral side pale yellow. Fins hyaline, unbranched dorsal rays usually dark.

The specific name is given after the common Telugu name for the fish.

In the key given by Whitehead (1967b), it is to be included among species having

(*a*) no pearly spots along flanks
(*b*) seven pelvic rays
(*c*) a short maxilla, not reaching beyond gill opening
(*d*) prepelvic scutes and
(*e*) 10-14 pectoral filaments ;

its position would be between *C. reynaldi* Val. and *C. coomansi* Harden :

(*a*) Scutes 4-6+8-9........................*C. reynaldi* Val.
(*b*) Scutes 7-9+9-11 (total, 17-19)..............*C. korua* sp. nov.
(*c*) Scutes 13-14+9-10..................*C. coomansi* Harden.

It is being recorded from Gollapalem in Krishna District, Andhra Pradesh. It occurs in coastal waters along with *C. dussumieri* and *C. ramcarati*.

ACKNOWLEDGEMENTS

The authors are thankful to Mr. S. Rama Rao and Mr. K. Varahala Raju, Department of Zoology, D.N.R. College, Bhimavaram, for their help during the investigations. One of us (BVSR) is thankful to the University Grants Commission for financial assistance.

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Keys to the Identification of Plant remains in Animal droppings

BY

SAVITHA SATAKOPAN
Drugs Laboratory, Baroda 2

(*With three plates*)

INTRODUCTION

This work was undertaken to assist the Bombay Natural History Society in their long term project on Ecological Research in Gir Forest in collaboration with Smithsonian Institution and Yale University, School of Forestry and financed by Smithsonian Foreign Currency Grant No. SFG-0-1894.

The help of this laboratory was required in this project to prepare and make available to the investigators, a diagnostic ' key ' using the microscopic characters of the plant debris present in the droppings of the wild animals at the Gir forest so that it could be used to ascertain the diet plants of these animals.

The work therefore involved the preparation of the supplied samples of faecal pellets and other allied materials in a form that would facilitate the microscopic identification of the plant debris present in them and the preparation of ' keys ' for the identification of their botanical source. The work was begun in July 1971 and completed by the middle of December.

MATERIALS

The following materials were supplied for the work through Mr. Berwick from Gir :

1. About 80 samples of plants of known identity, in dry state, consisting of twigs, and leaves and a few fruits in a few cases to serve as reference material.
2. About 90 samples of faecal pellets from a group of animals fed under control with known plant materials, to serve as reference material, and a list of about 20 plants that were the main diet of the animals.

3. About 20 samples from rumen of wild animals killed or dead, to serve as reference material.

4. About 140 samples of faecal pellets, being the droppings of wild animals like four-horned antelope, nilgai, sambar, chinkara, chital and hare.

METHODS

A. Preparation of materials :

(1) *Reference slides from known plant samples :*

Permanent slides were prepared for study from the reference materials. Since the plant materials were said to be authoritatively identified, no identification was done at this laboratory. The samples were processed in the following manner :

A few bits of leaves, twigs and fruits (where present) were taken from each sample. These were shredded coarsely and placed in a test tube. Chloral hydrate aqueous solution (50 g. in 20 ml) was added to the material in the test tube, (about 2 or 3 ml). The tube was heated in a water bath (water at boiling point) for a minute or two. Highly coloured materials took a second boiling with fresh quantities of chloral hydrate. The tube was allowed to cool, the liquid drained off, washed repeatedly in distilled water, dehydrated in alcohol, passed through grades of alcohol : xylol mixtures with the latter in increasing proportion, in successive mixtures, (alcohol : xylol ; 3 : 1, 1 : 1, 1 : 3) and finally, in pure xylol. The mounting was done in canada balsam or aroclor 5442, keeping the slides over a warming plate.

(2) *Reference slides from droppings of control group of animals :*

The faecal pellets were ' sampled ' according to a method described later. The pellets were triturated with water, boiled for a short time, allowed to cool, the supernatant with scum poured off, sediment washed twice or thrice in fresh quantities of water to clarify as much as possible prior to chloral hydrate treatment. They were then subjected to the same processing as explained above in chloral hydrate and mounted.

(3) *Slides from ' wild ' animal droppings :*

A *starting sample* of whole pellets (which is to be powdered later), was prepared in the following manner: The '*final sample*' in the form of powder which is clarified and mounted for observation, is taken in a manner indicated later,

B. Sampling Procedure adopted :

(1) *Pellets exceeding* 25 *in number :*

The sample is put in a tray, shaken and tossed about several times before spreading them on the tray ; it is first halved and then quartered. Two opposite quarters are combined ; one such combined portion is rejected. The remaining combined portion is shaken and tossed in the same manner, spread again, halved and quartered again ; opposite quarters are combined ; one combined portion is rejected, as in the first quartering and the other retained. The halving and quartering and combining is continued till there are 3 or 4 pellets in each quarter ; the opposite quarters are combined now to get two portions of 6 or 8 pellets each ; one of this is rejected and the other retained ; this is the *starting sample.*

(2) *For samples less than* 25 *but over* 5 *:*

The sample is put in a tray, rolled and tossed in all directions till the pellets are thoroughly mixed ; the sample is spread and individual pellets picked up from various portions till about six or eight are obtained ; This is the *starting sample.*

(3) *For samples that are five or less :*

Leaving one or two the rest of the sample is taken as the *starting sample.*

C. Preparation of the Final Sample :

The starting sample is put in a mortar and ground loosely so that pellets are broken up as discrete particles in a coarse powder form ; the grinding should not fractionate the particles but merely separate the agglomerates into single particles, large or small, as it may be. Three sieves (ASTM No. 30, 40, 50 approx.) are placed one above the other and the powder sieved ; the portion on the top sieve is rejected ; (A cursory examination under a stereo-microscope of the larger particles in this fraction before rejection would help in diagnosis later). The fractions of the middle and bottoms sieves, as well as that in the ' tails ' (portion that has passed through the bottom-most sieve) are stirred up and a little portion from each of the three are taken), they are mixed thoroughly, and halved ; one half is the '*final sample*' ; the other half should serve as *reserve* in case the final sample is lost in the subsequent processing ; after the slides have been made, the *reserve* may also be rejected. The final sample should not be less than a heaped coffee spoon.

The final sample is boiled in about 2 or 3 ml of chloral hydrate solution over a water bath of boiling water for a few minutes. If the chloral hydrate is too dark or coloured blackish, the powder is allowed to settle, supernatant poured off and fresh quantity of chloral hydrate added and the boiling repeated. In some cases a third boiling may be necessary. When the powder appears to the eye as fairly clarified, the cooking may be considered sufficient. After cooling distilled water is added and the material is shaken thoroughly, allowed to settle and supernatant poured off. This washing is repeated till all the chloral hydrate is washed off.

A dehydration process with alcohol follows, the washing being repeated two or three times to remove all water. Thereafter the same procedure of alcohol : xylol treatment as given for the other samples is followed and the final mounts are made in canada balsam or aroclor.

DIAGNOSTIC KEYS

(1) *Basis on which developed :*

The most difficult part of the work was the preparation of a satisfactory key. Any key devised for such a purpose as in this work should be based on characteristic evidences in the undigested plant debris present in the faeces. Such characteristics should not only be constant but also fairly specific for a plant. Microscopic characteristics of plants that are normally present in plant powders and serve for diagnosis are the epidermal cell characteristics, trichomes, crystalline or amorphous inclusions, fibres, quantitative indices like the number of ray cell tiers, palisade ratio, vein islet number, epidermal cells per unit area, stomatal number etc., and any other peculiarities. But in this work they were of limited value. The ubiquity of similar anatomical characters in a society of plants growing under similar ecological conditions, the absence of useful characteristic tissues due to digestion inside the animal, the loss of integrity of the tissue systems that could serve for diagnosis, and the severe changes undergone by the tissues and their contents making them unrecognisable, and other such causes lower the value of such characteristics as given above as diagnostic features. Keys based on epidermal tissue and on the mechanical tissues were prepared, but failed to be valid when tested on ' wild ' samples and were therefore rejected.

For the same reason, quantitative values could not be used as a basis for the key although these are very valuable, particularly the ' pallisade ratio ', in identification in intact tissue systems or pure vegetable powders. A single key based on a single factor was also found to be insufficient as it did not cover all the plants present in the debris. The problems were finally solved by preparing four different keys, keeping one as the ' main key ', and the others as ' supplementary '. The main key is based on the structure, dimension and abundance of the trichomes. The trichomes, which are a constant feature for any plant, were found to be undamaged in the faeces, presented sufficient variation and were easily recognised under the microscope. Of the selected 20 plants given by the workers as forming the chief diet of the wild animals, (as a result of their work with control animals) the main key serves to distinguish 60 to 70 per cent straightaway. Of the remaining, all except the five grasses can be located by combination of the main key and the supplementary keys and by cross-checking. A cross-checking is necessary because the trichomes are neither abundant nor peculiar in these, and the supplementary keys have been based on certain other features of these plants that are present in the debris. The only plant rather difficult to locate quickly is *Wrightia tinctoria*, and the characteristics of this plant has to be specially looked for in the preparations.

A key was prepared for the grasses but failed in application. Identification of grasses are much facilitated by the epidermal peel characteristics. But the debris in the pellets do not show sufficiently large intact epidermal pieces to be useful as basis for a key. For one, there are very few epidermal pieces in the pellets. Secondly, the pieces present are linear in shape rather than quadrangular, rarely more than 40 to 60μ in maximum dimension, so that the cell characteristics are not evident. Although the tiniest bit is sufficient to recognise a piece as ' grass ' it is very difficult to identify the species. The trichomes of the grasses are characteristic of the group as a whole but are inefficient as pointers for the identity of the individual. Therefore a key for the grasses had to be given up. The keys include the features of grasses only to differentiate between them and the other dicots as a whole.

It is also not possible to differentiate between *Acacia catechu* and *A. leucophloea*, although it is very easy to recognise *Acacia* as a genus.

But for these limitations, the key serves to identity about all the plants conclusively. The key has been applied and tested on about a hundred wild sample preparations for its validity. In the beginning there were about ten unknowns, but as work proceeded, four of these were identified up to the species level and two up to genus level. There are as yet three or four that cannot be identified, but it is certain that they are not from among the 80 plants supplied as reference by the workers.

(2) *Method of application of the Keys :*

A microscope equipped with preferably wide-field optics, giving a magnification range of 100X to 200X will be sufficient. A stereomicroscope, camera lucida or drawing apparatus, micrometers, tally counters are accessory equipment.

The most convenient magnification is about 150X. A field of view of about 0·8 mm diameter is available at this magnification. Although 100X magnification is also convenient for most particles in a field, this might require switching over to a higher power often for tinier particles. But a 150X shows up the details of tinier particles also and a change over to a higher power is required only occasionally for confirmation.

This work was done under the following conditions:

Microscope : Leitz Ortholux widefield binocular microscope :

Optics : 12·5X apochromatic objective and 12X aplanatic eyepieces ;

Area of one field of view at 150X : approx. 5 sq mm ;

Total area under a cover-slip covering the debris : approximately 380 sq mm with not less than 500 debris particles ;

No. of fields scanned for each preparation : about 75, i.e. the entire preparation ;

No. of particles normally present per field : 3 or 4 of the larger and 2 or 3 of the smaller.

No. of plants approximately present in a preparation : 6 to 8.

Up to 50% of a field has to be scanned carefully. Representative particles from almost all the plants present will have been located and identified by that time and the rest of the slide may be rapidly scanned for any omission. (The thorough mixing of the powder during the preparation of the slides ensures good distribution of particles, and makes this possible.) The slides are scanned field by field, in row after row, and the plants present identified using the main key based on trichomes. About 60% of the total plants present in a sample would be identified.

The slide is then searched again for pieces of tissues showing the characters given in the other keys for the remaining plants, that is, the epidermis, cuticle, crystals, trichome debris, fruit or seed coat debris etc. An example is given below :

Let us say a piece of cuticle is located, intact with group of epidermal cells. If the piece of cuticle is striated, item 2 under A of Key 3, will identify the plant. In case the cuticle is not striated, then the plant is possibly *Randia dumetorum*. The keys where other characteristics of *Randia* is given may be examined and some cross checking done for confirmation.

A thorough aquaintance with the genuine reference slides, practice with the identification and a judicious use of all the keys help the identification work.

(3) *Precaution to be observed while using the key :*

(*a*) Broken vascular fibres should not be confused with broken trichomes ; the former will show slit pits, greater width, a broad lumen and an irregular blunt tip.

(*b*) Proximity of particles from different origin would appear like a whole tissue of one origin and should not be confused with whole intact tissue. Each particle should be considered as a separate entity, unless actual tissue connection is observed between two particles. It often occurs that two particles from entirely different plants lie so closely together as to appear as one and the identity may be misconstrued. For instance, it is quite likely that the curly long trichomes of *Zizyphus jujuba* is entangled in a group of epidermal cells from *Boswellia serrata.* This might lead the observer to miss the presence of the latter and consider only the former to be present. Or the veinlet skeleton of one leaf may lie cunningly over the lamina of another plant and the two taken together might resemble a third one.

(*c*) Isolated crystals, completely free of tissues are helpful, as their dimension and morphology will denote their origin but when such crystals are seen in association with other tissues, it must be made certain that the crystals are within an intact cell. Only then these will serve for diagnosis. If not, they can completely mislead the observer, as they may merely be superimposed on some tissue to which it does not belong.

(*d*) No key should be applied without having studied the reference slides ; the key cannot be successfully applied by a person without botanical knowledge ; that is, application of the key is not a mechanical job.

(*e*) The keys have been built up from the debris present in the pellets of the ' wild ' samples. Several tissue pieces from the genuine reference plant may not be *exactly similar* to the same tissue pieces in the faecal debris in spite of the same processing done in both cases in the preparation of the material. Therefore the observer need not be puzzled if the same characteristic from the reference slides and the ' wild ' slides are not exactly similar. At times this is confusing enough to feel that the plant is a different one from those in the ' keys ', but actually it is not so. An illustration may make this clear : The cuticles of trichomes are generally intact in the slides made from the genuine plants. But the trichomes of the same plant may lose their cuticle in their passage through the animal. This produces a slight change in the morphology of the trichome, particularly with regard to the walls. In *Butea monosperma,* the multicellular trichome shows the cross partitions of the basal cells very clearly, when cuticle is intact, if the reference slides are seen. But this is only rarely so in the trichome when it appears in the debris where the cuticle is many times lost. The partition walls of the basal cells become indistinct and only the apical cell wall is clearly seen. A careful scrutiny under higher power would reveal the individual basal cells. Another plant that shows a slight difference is *Terminalia bellerica.* This difference in the clarity of the wall may be due to the strength and amount of lignin in the walls of the trichome. Whatever the reason may be, it is necessary to follow the key closely, even if morphologically and at low power, there appears to be a slight difference from what the key implies and what the debris reveals.

1. KEY BASED ON INTACT TRICHOMES

A_1 **Trichomes without arms :**

  B_1 Trichomes unicellular :

    1. not over 500 microns in length ; lumen as broad as or broader than the total width of walls at the base ; cuticle, slightly warty .. *Acacia* spp.*
    2. over 500 microns in length ; yellowish tinged, narrow, cylindrical and almost solid like a cord ; lumen almost absent ; base showing a conical partition .. *Anogeissus latifolia*
    3. up to 500 microns or sometimes slightly more ; spinelike and straight ; cuticle warty ; lumen narrow ; epidermal cells at the base of trichome thickwalled .. *Sapindus emarginatus*

  B_2 Trichomes multicellular and uniseriate:

    1. under 200 microns, six to seven cells in a short row, stubby and blunt, smaller ones papillose .. *Emblica officinalis**
    2. under 200 microns generally, 3 to 4 broad cells of approximately equal height but decreasing width, thin walled, at times covered with loosely fitting cuticle .. *Neuracanthus sphaerostachys**
    3. over 500 microns, 2 or 3 basal cells in a short row, apical cell alone very long, at times septate, tips acute .. *Butea monosperma*
    4. over 500 microns, single basal cell, and a very long apical cell .. *Terminalia bellerica*

  B_3 Trichomes not truly multicellular, but merely septate :

    C_1 Up to 300 microns long; cuticle warty ; lumen broader than wall widths ; blunt or rounded tips .. *Bauhinia racemosa**

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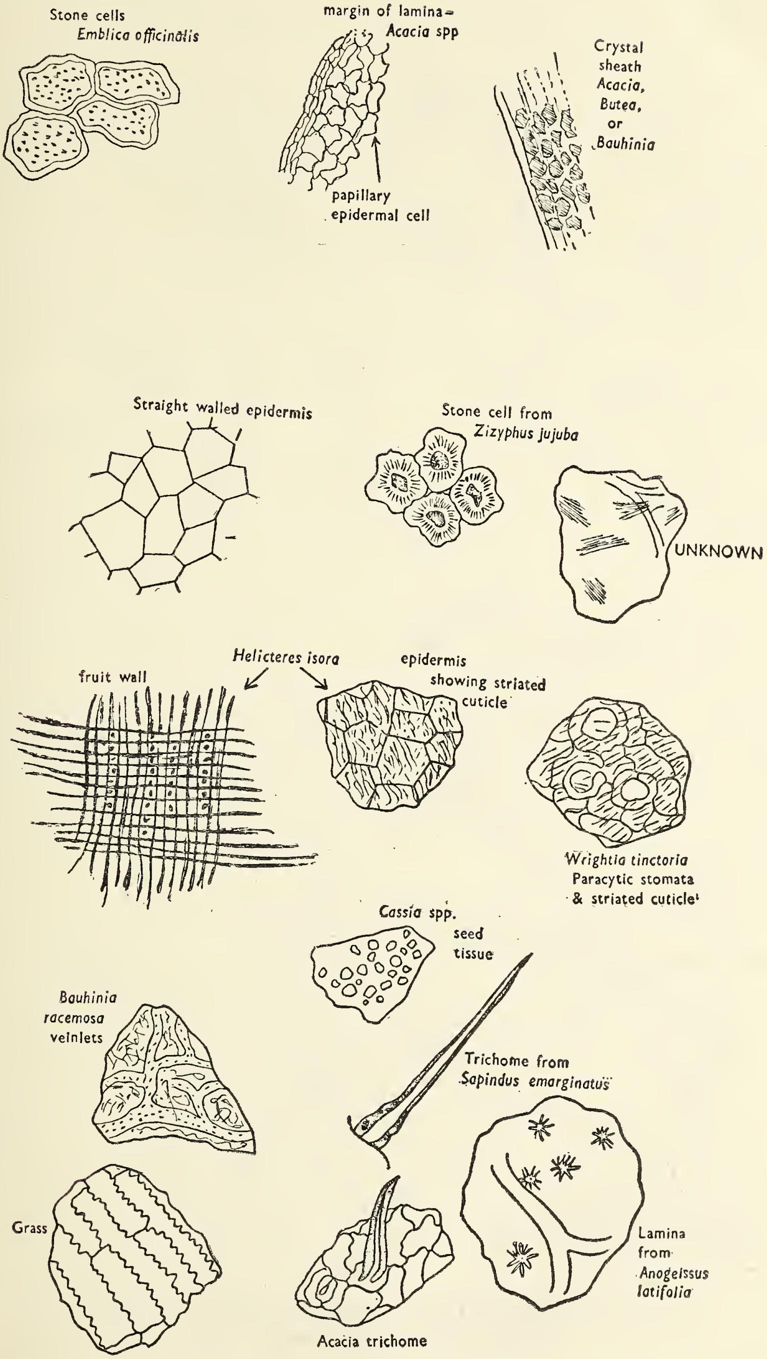
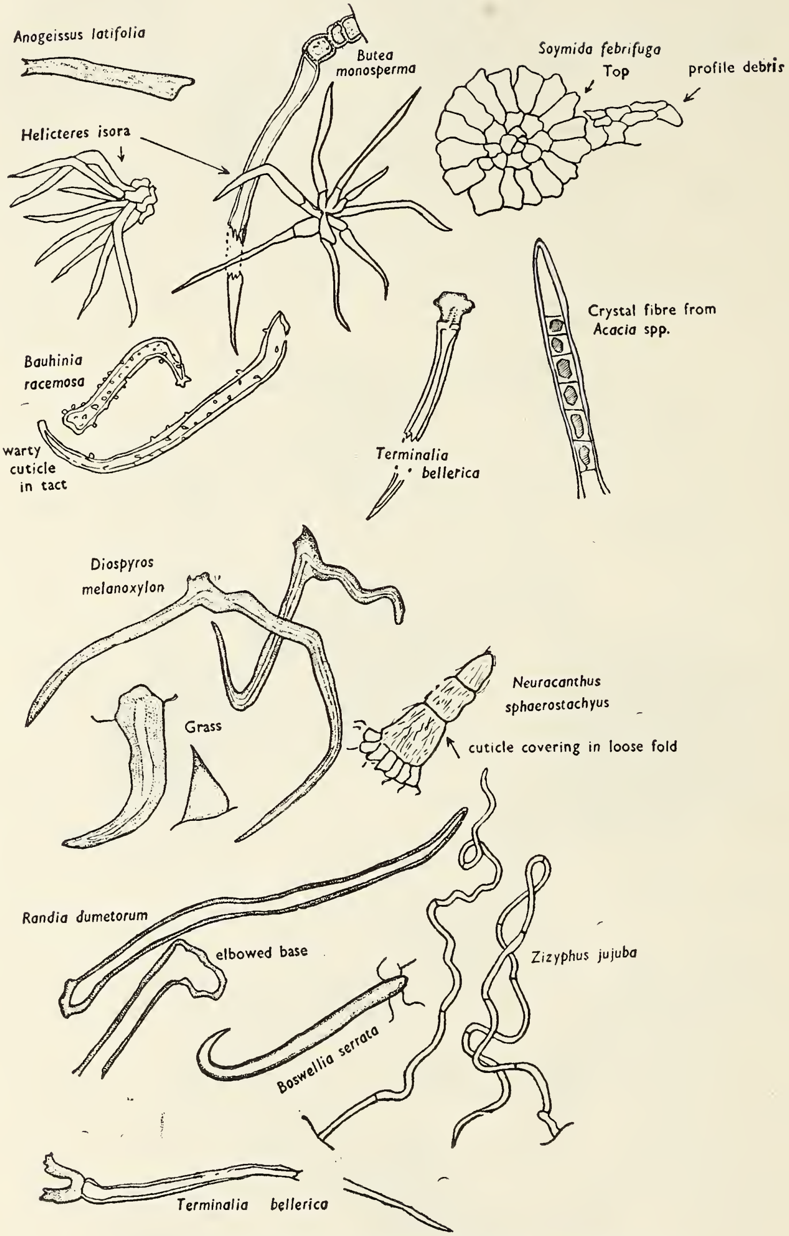
* Trichomes not abundant

Satakopan: *Plant remains*


Stone cells
Emblica officinalis
margin of lamina – Acacia spp
papillary epidermal cell
Crystal sheath Acacia, Butea, or Bauhinia
Straight walled epidermis
Stone cell from Zizyphus jujuba
UNKNOWN
Helicteres isora
fruit wall
epidermis showing striated cuticle
Wrightia tinctoria
Paracytic stomata & striated cuticle
Cassia spp.
seed tissue
Bauhinia racemosa veinlets
Trichome from Sapindus emarginatus
Grass
Acacia trichome
Lamina from Anogeissus latifolia

Freehand sketches of matter from pellet samples as they appear under the microscope

Satakopan : *Plant remains*


Anogeissus latifolia
Butea monosperma
Soymida febrifuga
Top
profile debris
Helicteres isora
Crystal fibre from Acacia spp.
Bauhinia racemosa
warty cuticle in tact
Terminalia bellerica
Diospyros melanoxylon
Grass
Neuracanthus sphaerostachyus
cuticle covering in loose fold
Randia dumetorum
elbowed base
Zizyphus jujuba
Boswellia serrata
Terminalia bellerica

Freehand sketches of matter from pellet samples as they appear under the microscope

C_2 Trichomes up to 500 microns long or occasionally even more :

1. shorter ones sickle-shaped, slender, slightly warty cuticle, about 20 microns in width at the middle, base not differentiated, tips acute .. *Boswellia serrata**
2. cuticle not warty, but in loose folds ; trichomes up to 30 microns or more in width ; base bulbous or shaped like an elbow ; lumen broader than total wall widths .. *Randia dumetorum**

C_3 Trichomes well over 500 microns and even up to a mm or so; thin walls, flat and ribbon-like ; very curly and abundantly present .. *Zizyphus jujuba*

A_2 **Trichomes with arms :**

1. two unequal arms, thick and massive, longer arm up to or over 500 microns occasionally, and 35 microns in width, lumen present right up to the tip ; tips acute .. *Diospyros melanoxylon*
2. Dendritic, with blunt, short conical branches ; interwalls pitted ; walls thin and lumen broad .. *Tectona grandis*
3. Stellately branched, with 6 to 8 arms from the base ; arms ranging from 50 to 500 microns in length, tips acute and solid; walls thicker than lumen width, except at the base .. *Helicteres isora*
4. characteristically peltate, with a short stalk and a central group of cells and a peripheral set or ray-like cells .. *Soymida febrifuga*

2. KEY BASED ON CRYSTALLINE INCLUSIONS AND VASCULAR SYSTEMS

A_1 **Vascular systems of veins and shoot apices in close association with crystalline inclusions :**

B_1 Abundant single prismatic crystals only :

(1) present in parenchyma cells forming a sheath surrounding the vascular fibres; also present at random in mesophyll, often in the form of cross .. *Butea monosperma*

(2) present as above, as well as inside fibres in partitioned tiers .. *Acacia* spp.

(3) present as in 1 above, but absent from the mesophyll .. *Bauhinia racemosa*

B_2 Abundant crystals in the form of clusters of rosettes as well as single ones :

(1) rosettes in greater number, diameter up to 40 microns .. *Boswellia serrata*

(2) rosettes in lesser number, more abundant prisms, large and tabloid .. *Sapindus* spp.

A_2 Vascular systems of veins and shoot apices not in close association with crystals but crystals present in other parts :

B_1 Crystals distributed at random over soft tissue :

(1) xylem vessels pitted with laterally compressed wide pits, appearing scalariform ; large prisms and rosettes present in cortical and pith cells and in mesophyll .. *Emblica officinalis*

(2) xylem vessels wide, pits circular, end-perforation of vessel simple and vessel spurred ; pericyclic fibres present .. *Wrightia tinctoria*

B_2 Crystals only in idioblasts and not at random over the soft tissues :

(1) rosettes over 40 microns in diameter, up to nearly 80 microns ; vascular system showing abundant tracheids and tracheid-fibres .. *Terminalia* spp.

(2) rosettes up to 40 microns or over in diameter, but no tracheids or tracheid-fibres ; vascular fibres present .. *Randia dumetorum*

A_3 Crystals in the form of cystoliths :

(1) clusters in the lamina, very often beneath massive trichomes, epidermal cell walls thick at these places .. *Tectona grandis*

(2) cystoliths in special elongated cells below epidermis, one end broad and other end tapering .. *Neuracanthus sphaerostachys*

3. KEY BASED ON MISCELLANEOUS DEBRIS

A. Cuticle :

1. pieces of cuticle without striations, but with the outline of epidermal cells faintly impressed upon it .. *Randia dumetorum*

2. pieces of cuticle, closely striated, usually intact with the epidermis :

(*a*) cell walls of upper epidermis (no stomata present) very sinuous .. *Diospyros melanoxylon*

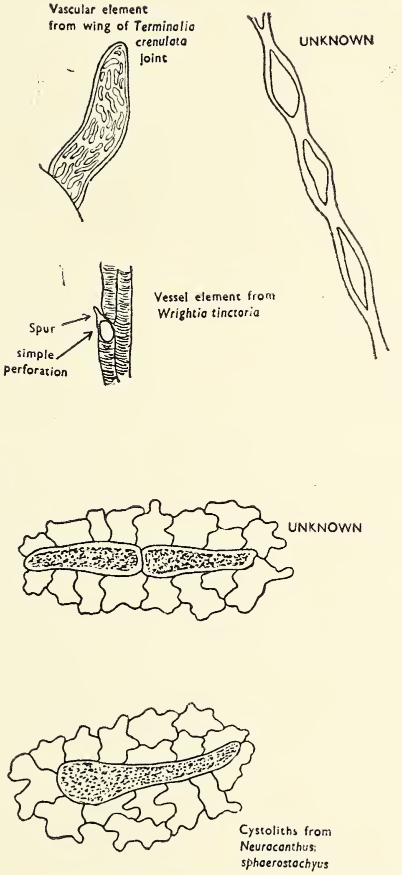
(*b*) cell walls of epidermis not sinuous, but wavy to straight :

(*i*) cells of upper epidermis (no stomata) about 10 per 100 microns square .. *Helicteres isora*

(*ii*) cells of upper epidermis (no stomata) about 15 per 100 microns square .. *Wrightia tinctoria*

(*iii*) cells of lower epidermis (stomata present) with anomocytic stomata .. *Soymida febrifuga*

(*iv*) as (*iii*) above, but with paracytic stomata .. *Wrightia tinctoria*


Vascular element from wing of *Terminalia crenulata* joint
UNKNOWN
Vessel element from *Wrightia tinctoria*
Spur
simple perforation
UNKNOWN
Cystoliths from *Neuracanthus sphaerostachyus*

Freehand sketches of debris from pellets of ‘wild’ samples as they appear under the microscope [illegible] [illegible]

[illegible]

[illegible]

B. Epidermal cell groups without cuticles :

1. Walls quite straight :

(*a*) no. of epidermal cells per 100 microns square 15 or over .. *Bauhinia racemosa*

(*b*) no. of epidermal cells per 100 microns square 20 or over .. *Butea monosperma*

(*c*) no. of epidermal cells per 100 microns square 10 or over and walls thin .. *Zizyphus jujuba*

(*d*) as (*c*) above, but walls thick .. *Boswellia serrata*

C. Detached trichomes with their cuticles intact or missing :

1. a solid basal portion with walls so thick as to almost obscure the lumen ; rest of the trichome much thinner walled in comparison (cuticle occasionally missing) ; cuticle warty, if intact .. *Boswellia serrata*

2. trichomes generally up to 500 microns long and about 30 microns broad ; base bulbous or elbowed, lumen broader than both wall widths ; cuticle in loose folds, if present .. *Randia dumetorum*

3. basal cells showing thick wall and narrow lumen, apical cell thin-walled and very long .. *Terminalia bellerica*

4. basal cells 2 or 3 in no.: at times their walls unlignified and so faint as to be obscure ; apical cell alone very long, at times septate, always with well defined lignified walls and broad lumen (cuticle occasionally missing) .. *Butea monosperma*

5. base showing thick conical projection ; yellowish and lignified, rest of the trichome cylindrical with narrow lumen ; over 500 microns long .. *Anogeissus latifolia*

6. stout, unicellular, very thick, striated lignified walls with yellowish tinge ; spine-like or prickle-like ; less than 300 microns long .. Any grass

4. KEY BASED ON FRUIT TISSUES

A. Pieces of tissue consisting of two layers of much elongated, palisade-like sclereids, laid criss-cross one over the other lightly or densely brown :

1. number of sclereids containing prismatic crystals in a neat single file ; not associated with stone cells containing crystals .. *Helicteres isora*

2. same as above, but sclereids very narrow, lumen almost absent ; rarely containing crystals ; associated often with groups of stone cells containing plenty of scattered crystals .. *Randia dumetorum*

B. *Groups* of stone cells*.

1. Typical, irregular, very thick-walled, pitted stone cells, about 100 microns in length and less than that in width ; lumen filled with dark substance .. *Zizyphus jujuba*
2. cells over 500 microns in length, wide lumen, walls not very thick, pits very fine and close, like stipples .. *Emblica officinalis*

C. Groups of very sinuous cells, about one or two per 100 microns square, thin to thick-walled, from epidermis of young fruits .. *Tectona grandis*

**N.B.*—The stone cells of *Diospyros melanoxylon* is fairly similar, and can be recognised (in the absence of *Zizyphus jujuba*) by the fact that the characteristic trichomes would also be present ; if both these plants have been eaten it is not possible to distinguish between the stone cells, but then the trichomes would indicate their presence without doubt.

ACKNOWLEDGEMENTS

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A new Genus and Species of Fruit Bat from South India (*Chiroptera*: *Pteropodidae*)

BY

KITTI THONGLONGYA[1]

(*With six plates*)

While studying the Megachiroptera deposited in the collections of the Bombay Natural History Society, Bombay, India, an undescribed species was noticed. With the peculiar characteristic of this new bat, a new genus, *Latidens*, is proposed.

LATIDENS gen. nov.

Characters: A moderate-sized megachiropteran bat of the Cynopterine section of the subfamily Pteropodinae as defined by Andersen (1912, p. xcv). It possesses only one pair of upper and lower incisor, $I = \frac{1-1}{1-1}$, a character known among the megachiroptera in *Dobsonia* (Palmer 1898), *Haplonycteris* (Lawrence 1939), and *Harpyionycteris* (Thomas 1896). However, *Harpyionycteris* is placed in the Subfamily Harpyionycterinae, recognized as possessing strongly proclivous upper incisors and upper and lower canines.

Latidens is easily separated from the other genera mentioned above by having the cheek teeth $\frac{4-4}{5-5}$. These are $\frac{5-5}{6-6}$ in *Dobsonia* and $\frac{4-4}{4-4}$ in *Haplonycteris*. The postorbital foramen is absent in *Latidens* as well as in *Aethalops*, *Balionycteris*, *Chironax*, *Haplonycteris*, *Thoopterus*, *Penthetor* and *Sphaerias*, but *Latidens* is separated by the number of incisors.

Koopman & Cockrum (1967, pp. 115-116) recognized 29 genera among the Subfamily Pteropodinae. Table 1 gives the tooth formulae for the genera among the Cynopterine section including *Latidens* gen. n.

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[1] Curator of Terrestrial Vertebrates; Centre for Thai National Reference Collections (CTNRC); Applied Scientific Research Corporation of Thailand (ASRCT); 196 Phahonyothin Road, Bangkhen, Bangkok-9, Thailand.

The cheek teeth of *Latidens* are very broad, especially the lower cheek teeth, which resemble those of *Thoopterus* and *Dyacopterus*[2].

TABLE 1

TOOTH FORMULAE OF PTEROPODINAE (CYNOPTERINE SECTION)

Genus			Incisors	Toothrow	Remarks
1. *Aethalops*	Thomas	1923	$\frac{2-2}{1-1}$	$\frac{4-4}{5-5}$	Malaysia
2. *Balionycteris*	Matschie	1899	$\frac{2-2}{1-1}$	$\frac{5-5}{5-5}$	Malaysia
3. *Chironax*	Andersen	1912	$\frac{2-2}{2-2}$	$\frac{4-4}{5-5}$	Malaysia
4. *Cynopterus*	F. Cuvier	1825	$\frac{2-2}{2-2}$	$\frac{4-4}{5-5}$	India & Malaysia
5. *Dyacopterus*	Andersen	1912	$\frac{2-2}{2-2}$	$\frac{3-3}{5-5}$	Borneo
6. *Haplonycteris*	Lawrence	1939	$\frac{1-1}{1-1}$	$\frac{4-4}{4-4}$	Philippines
7. *Megaerops*	Peters	1865	$\frac{2-2}{1-1}$	$\frac{4-4}{5-5}$	Thailand & Malaysia
8. *Myonycteris*	Matschie	1899	$\frac{2-2}{2-2}$	$\frac{5-5}{6-6}$	Africa
9. *Penthetor*	Andersen	1912	$\frac{2-2}{1-1}$	$\frac{4-4}{5-5}$	Malaysia
10. *Ptenochirus*	Peters	1861	$\frac{2-2}{1-1}$	$\frac{4-4}{5-5}$	Philippines & Borneo
11. *Sphaerias*	Miller	1906	$\frac{2-2}{2-2}$	$\frac{4-4}{5-5}$	Burma & Thailand
12. *Thoopterus*	Matschie	1899	$\frac{2-2}{2-2}$	$\frac{4-4}{5-5}$	Celebes
13. *Latidens* gen. n.	K. Thonglongya	1971	$\frac{1-1}{1-1}$	$\frac{4-4}{5-5}$	South India

The rostrum of the skull is rather elongate, narrow and thickened. The orbitonasal length is about 28% of the occipitonasal length. The palate is narrow and very long especially the postdental palate[3].

Type Species : *Latidens salimalii* sp. nov.

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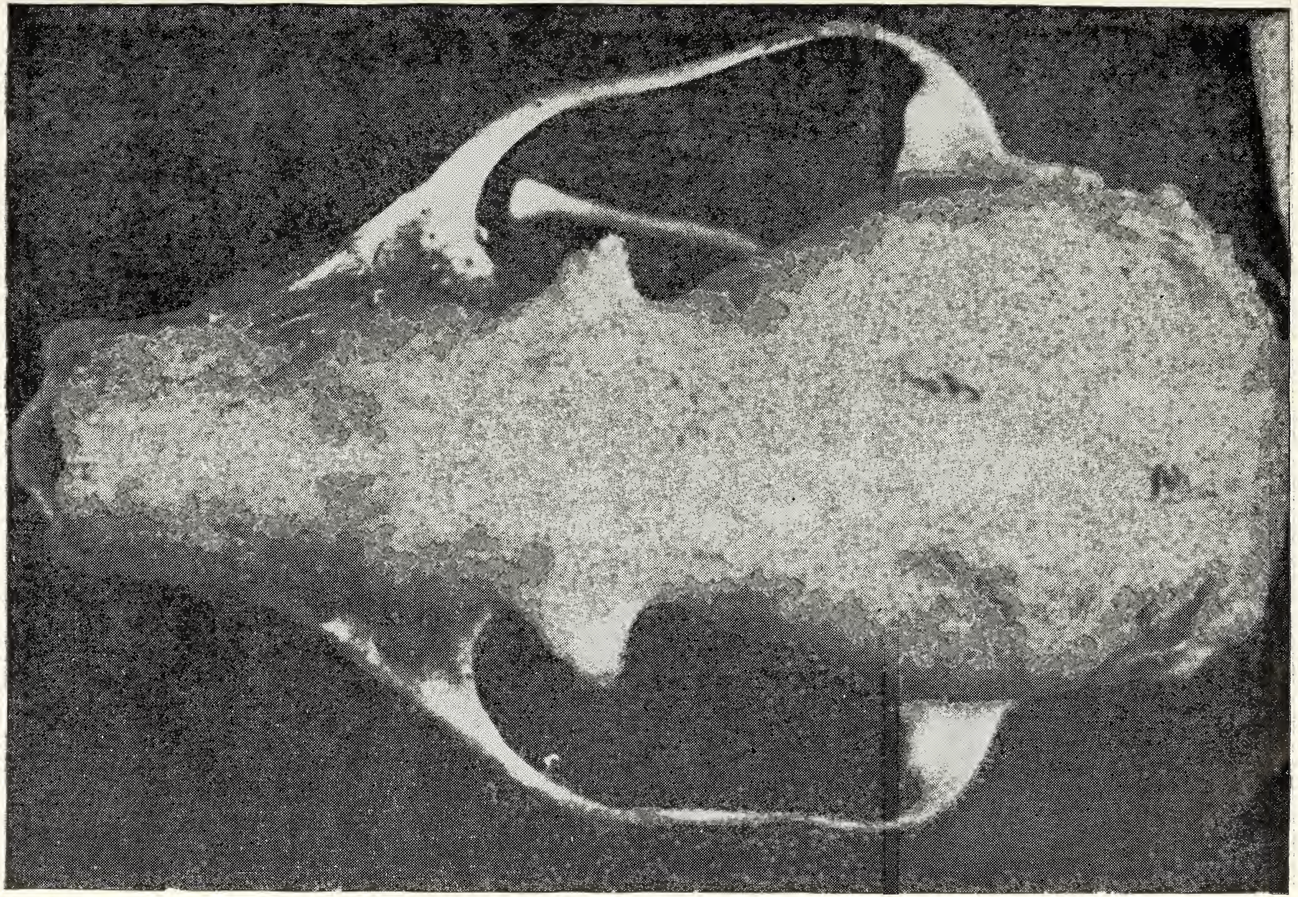
[2] John Edward Hill, who reviewed this manuscript and saw the specimen of *Latidens* remarked as follows, ' While the cheek teeth of *Latidens* are broad, they are by no means as broad as the very aberrant cheek teeth of *Thoopterus* : neither, apart from their width do they resemble those of *Dyacopterus*, in which the cusp pattern is basically that of *Cynopterus*. The cheek teeth (i.e. pm $\frac{3}{3}$, pm $\frac{4}{4}$, m $\frac{1}{1}$ and m_2) of *Latidens* in fact closely resemble those of *Penthetor*, except that they are little wider, m^1 is square, not tapered posteriorly and does not extend posteriorly beyond the ventral margin of the orbit, while pm_4 and m_1 have a low surface cusp, approaching *Thoopterus* in this respect.'

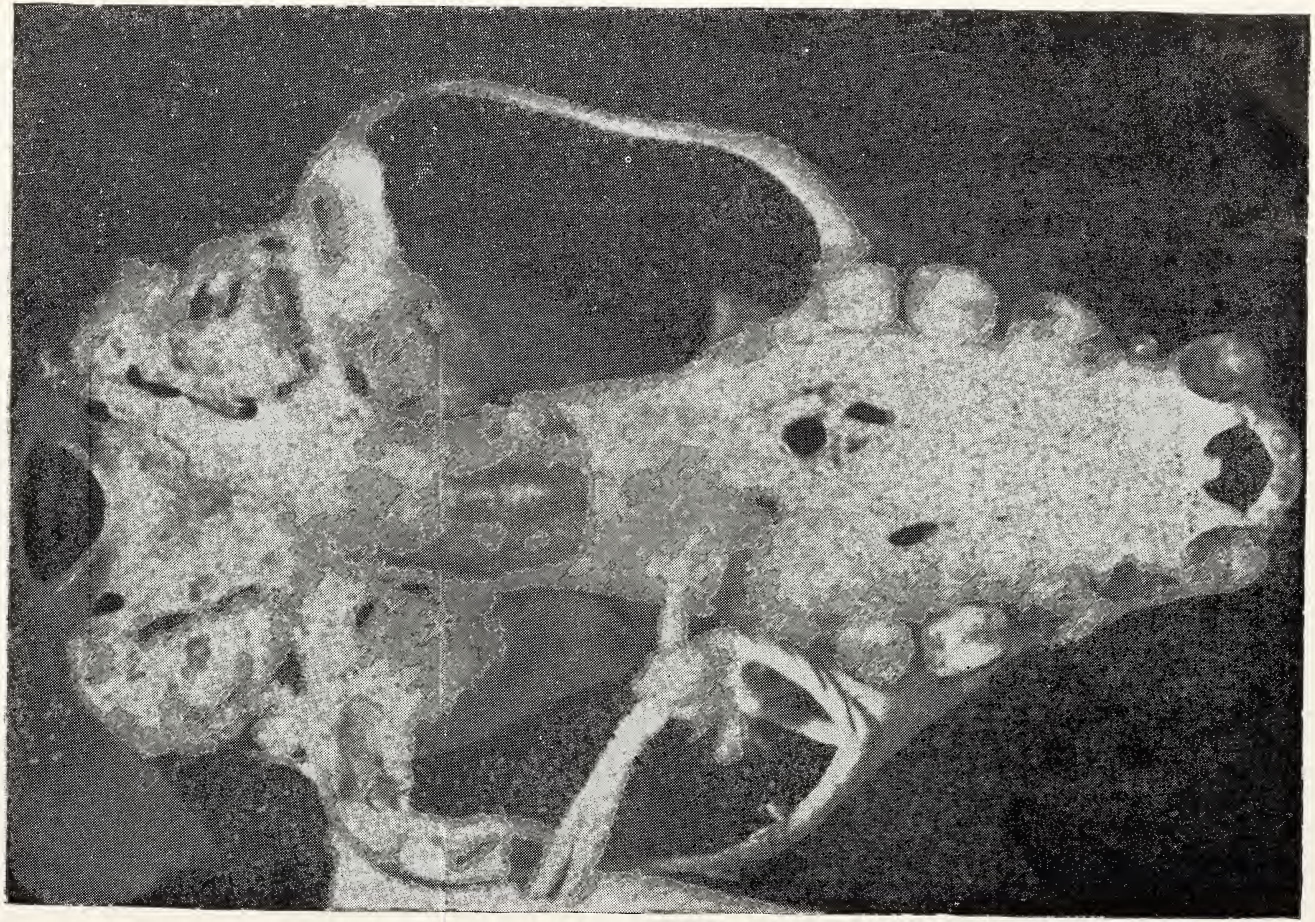
[3] Hill further remarked : The rostrum is very similar to that of *Thoopterus* but is a little less massive and deep. It is not especially elongate in comparison with *Thoopterus* but is more slender, a feature reflected in the narrowness of the palate, especially anteriorly. The postdental palate is relatively longer than in most Cynopterine bats but is equalled in this respect by *Aethalops*.

Thonglongya : *Latidens salimalii*



Dorsal aspect of skull of × 5

Thonglongya : *Latidens salimalii*



Ventral aspect of the skull × 5

Latidens salimalii sp. nov.

Type: B.N.H.S. no. 1563, an adult, sex not recorded but probably male, collected by A. F. Hutton from High Wavy Mountains, Madura district, South India, about 2500 feet, on 2 May 1948.

DESCRIPTION: A medium sized bat, similar to *Cynopterus sphinx angulatus* but without external tail. The fur of the head is blackish brown with light greyish base, darker than that of the body. The body fur is dense and longer than *Cynopterus sphinx*, light brown in colour, about 5 mm long on the mid back. The fur of the underparts, including chin and throat is thinner and shorter than that of the upper parts and is light greyish brown in colour. The ear membrane is rather thin, oval in shape, without a white rim as in *Cynopterus*. The index claw is present. The nostril, as seen from dry skin, has a Cynopterine form. The wing membrane is brownish, rather thin, starting from the first toe of the foot, and with no white along the fingers as in *Cynopterus*. The third metacarpal is the longest, the fifth is a little shorter than the fourth, which, in turn, is shorter than the third. Hill (in litt.) inform that externally and in colour, this bat almost exactly resembles *Thoopterus*. The wing-indices of the Cynopterine section will be seen from the appendix. Compared with related genera, the calcar is rather short, about 2 mm long, measured from the dry skin.

APPENDIX

COMPARISON OF THE WING INDICES BETWEEN THE GENERA OF FRUIT BATS IN CYNOPTERINE SECTION

Genus	FA	III MC	III^1	III^2	IV MC	IV^1	IV^2	V MC	V^1	V^2
Balionycteris (p. 656)	1000	719	512	616	697	404	384	714	347	342
Chironax (p. 659)	1000	636	489	632	598	375	420	632	330	348
Cynopterus (p. 592)	1000	640	429	568	599	326	378	625	305	336
Dyacopterus (p. 653)	1000	703	452	548	677	394	335	690	303	290
Haplonycteris (Lawrence, p. 34)	1000	714	—	—	637	—	—	689	—	—
Megaerops (p. 648)	1000	658	467	585	620	357	375	643	313	321
Myonycteris (p. 577)	1000	671	465	575	633	342	366	647	302	323
Nyctimene (p. 689)	1000	708	536	658	646	404	453	678	334	375
Penthetor (p. 668)	1000	650	423	602	609	631	398	617	278	327
Ptenochirus (p. 644)	1000	645	436	594	604	339	373	628	309	337
Thoopterus (p. 664)	1000	694	510	585	660	394		680	306	306
Latidens gen. n.	1000	684	471	620	658	363	400	654	318	

Remarks:—All these measurements were taken from Andersen (1912), the page numbers being given in parentheses. Lawrence gave only metacarpal measurements for *Haplonycteris*.

Skull: (pl. 1-pl. 6). The skull is long and massive, and slightly deflected. The rostrum is also heavy and thickened and the postorbital process is very short but heavy, lacking the postorbital foramen. The lambdoidal crest is present on both sides but not well marked. The zygomatic plate is slender and narrow ; the anterior part leaves the skull from the posterior end of pm^4, and is attached to the skull at the posterior of m^1 (see plate 2). The interorbital foramen is large and oblong.

The palate is narrow and long when compared with related genera, especially the postdental palate, which is longer than usual among the Cynopterines. The palatal ridge is not present.

The bullae are small and not much swollen. An incipient but distinct ' basial pit ' is present.

Dentition :

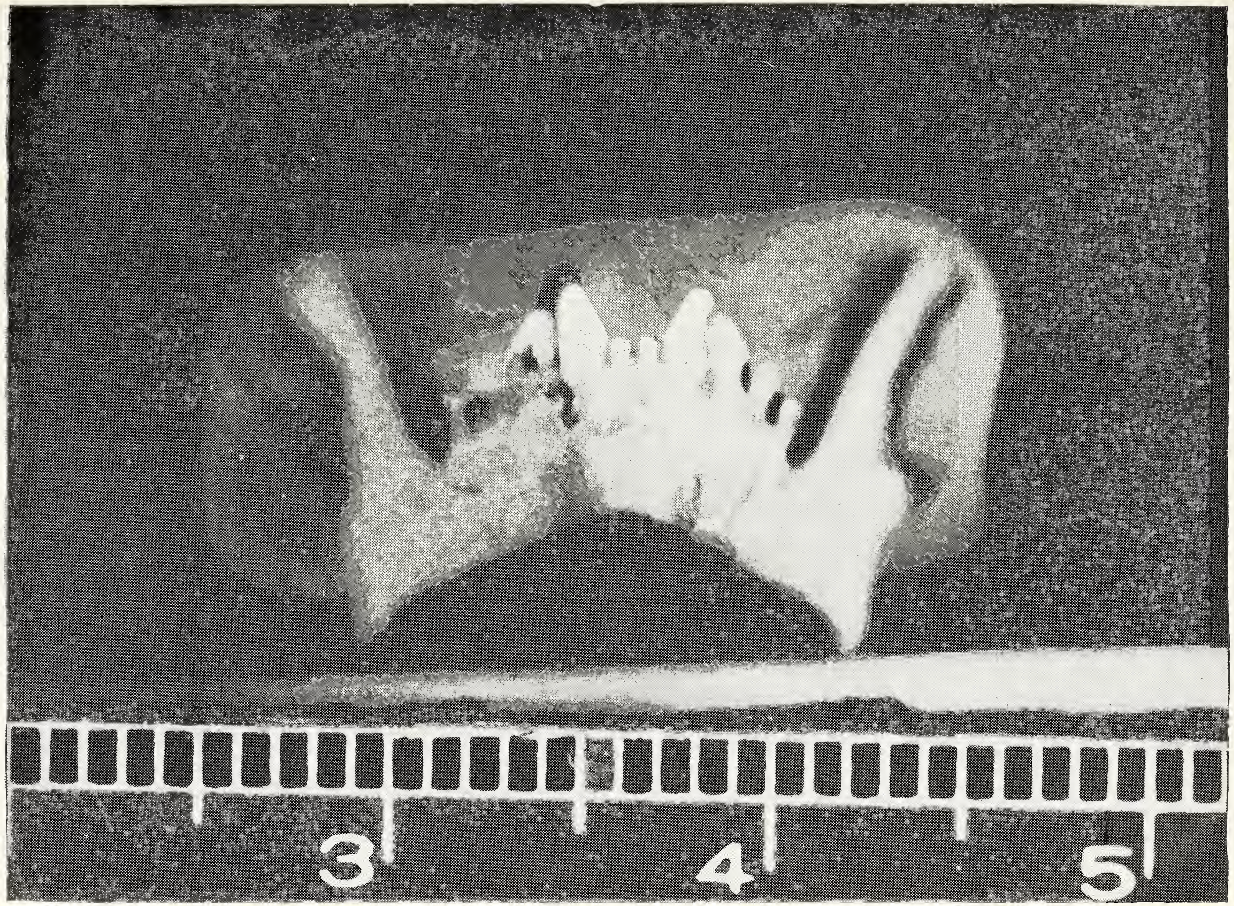
$$\frac{i^2 \; c \; pm^1 \; pm^3 \; pm^4 \; m^1}{i_2 \; c \; pm_1 \; pm_3 \; pm_4 \; m_1 \; m_2} \times 2 = 26$$

The upper incisors are styliform i.e. rod-like with flat crown. There is a little space between them and canines. The upper canine is smaller than that of *Cynopterus sphinx*, straight, with anteromedian groove, but having no secondary cusp. The first premolar (pm^1) is the smallest of the upper cheek teeth but comparatively larger than the first premolar among the other Cynopterine genera. It appears to be functional. Pm^3 is larger and higher than pm^4, oval or subsquare in outline. Although pm^4 is shorter and smaller, it is much broader and rather more square than round or oval ; also retains the anteroexternal cusp. M^1 is smaller than pm^4 as usual. The shape of this tooth is like pm^4 and it also retains the anteroexternal cusp, but is lower.

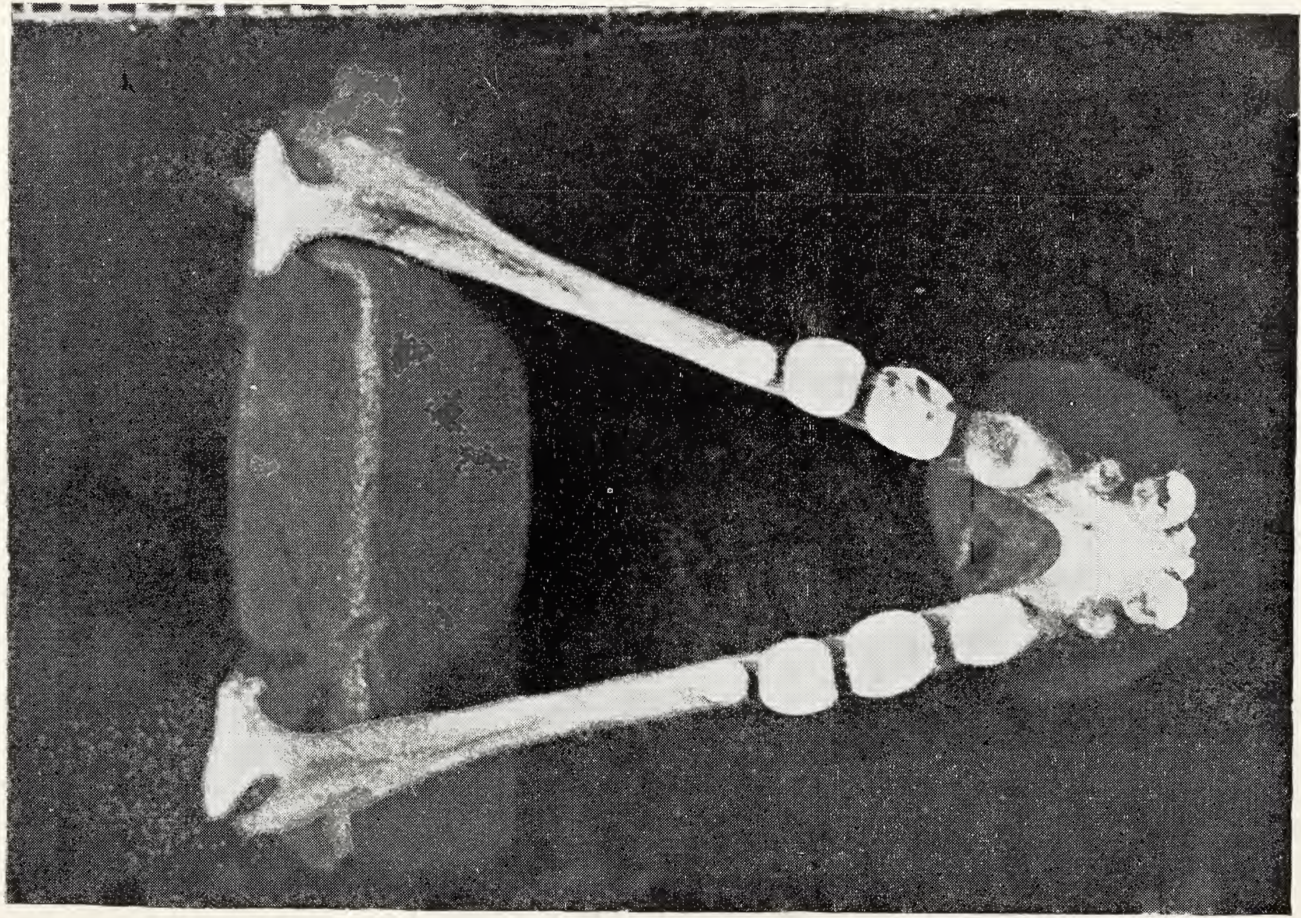
The lower incisor is also styliform but differs mainly from the upper incisor in being flat, sharp crowned rather than rounded. It is decidedly smaller than the upper incisor, about half the length of the lower canine. The lower canine is much smaller than the upper canine and set close to the lower incisor. It is much thickened at the posterior base but there is no well-defined secondary cusp. Pm_1 is also set close to the canine with a little space between them, and very small. Pm_3 is the highest and largest tooth of the lower toothrow, but it retains the posteroexternal cusp. Pm_4 is as large as pm_3 but much shorter and broader, subsquare in shape as in the other teeth. Only the anterior lower premolar (pm_1) has a clear outer cusp with a faint inner ridge. M_1 is also smaller than pm, also subsquare in outline, broader than pm_3 with a trace of central cusp. M_2 is about half smaller than m_1, oval or rounded.

Measurements : As the collector gave no field measurements, all measurements here were taken from the dry skin and are given in millimetres.

Thonglongya: *Latidens salimalii*



Anterior view of the lower mandible showing the lower incisors × 5



Upper part of the Mandible ×5

EXTERNAL MEASUREMENTS

Forearm	67·5
Tibia	20·0
Calcar	2·0
Pollex (with claw)	24·5
Third metacarpal (III Mc)	46·2
*III^1	31·8
III^2	42·0
Fourth metacarpal (IV Mc)	44·4
IV^1	24·5
IV^2	27·0
Fifth metacarpal (V Mc)	44·1
V^1	21·5
V^2	20·0 (shrunk)

*After Andersen in using III^1 for the first phalange of the third metacarpal, III^2 for the second phalange of the third metacarpal, IV^1 for the first phalange of the fourth metacarpal, and so on.

SKULL MEASUREMENTS

Greatest length	34·3
Occipitonasal length	32·1
Condylobasal length	33·8
Zygomatic width	21·3
Braincase width	13·7
Interorbital width	7·4
Postorbital width	7·7
Median palatal length	18·6
Length of postdental palate	6·3
Rostrum (orbitonasal length)	8·3
Breadth of rostrum between lachrymal foramina	8·0
Lachrymal width	10·0
c^1 - c^1 (alveoli, external)	6·1
m^1 - m^1 (crowns, external)	10·8
Breadth of palate at the posterior end	5·2
Length of upper toothrow (c - m^1), alveoli	11·3
Length of lower toothrow (c - m_2), alveoli	12·4
Length of upper mandible	25·0

MEASUREMENTS OF THE TEETH OF *Latidens salimalii*

	Upper tooth row	Lower tooth row
Height of canine	4·2	2·5
Third premolar (pm $\frac{3}{3}$) (L×W×H)	2·4×1·9×2·3	2·5×1·9×2·2
Fourth premolar	2·2×2·2×1·6	2·4×2·3×1·5
First molar	2·0×1·8×1·0	1·8×2·1×1·1
Second molar	—	1·2×1·1×0·5

Affinities with other genera in Pteropodinae :

This new bat no doubt belongs to the Cynopterine section as defined by Andersen (1912, pp. lvi-lxi). J. E. Hill (in litt.) suggested that *Latidens* is closely related to the Malaysian *Penthetor* and the Celebesian *Thoopterus.* I fully agree. It differs from *Penthetor* in the absence of the outer upper incisors (in *Penthetor*, however, these are reduced to one half of the length of the inner pair), in the longer, stronger, rostrum, and in having slightly wider pm $\frac{3-4}{3-4}$ and m $\frac{1}{1}$, in the square and not wedge-shaped outline of m^1 which does not extend posteriorly beyond the ventral margin of the orbit and in the presence of surface ridges on pm_4 and m_1. In the features of rostrum, it is similar to *Thoopterus* : the widening of the teeth approaches but does not equal the extreme condition found in *Thoopterus* in which m_1 does not extend posteriorly and which has the similar but stronger surface ridges on pm_4 and m_1. It may be considered that *Latidens* is the counterpart in India of the Malaysian *Penthetor* and Celebesian *Thoopterus.*

Specimen examined : 1, only the type.

Remarks : A. E. Hutton, the collector, mistook this bat for the common species in India, *Cynopterus sphinx*, and labelled it as such. In his paper (1949, a & b), he gave details about the type locality of this bat and made a note about *Cynopterus sphinx* as follows :—

'*Cynopterus sphinx.* Short-nosed Fruit Bat, (Tamil : Baaval). The commonest in the hills where it is often seen in the evenings, flitting about the edges of the jungle, catching moths and other insects on the wing. (? Ed.).'

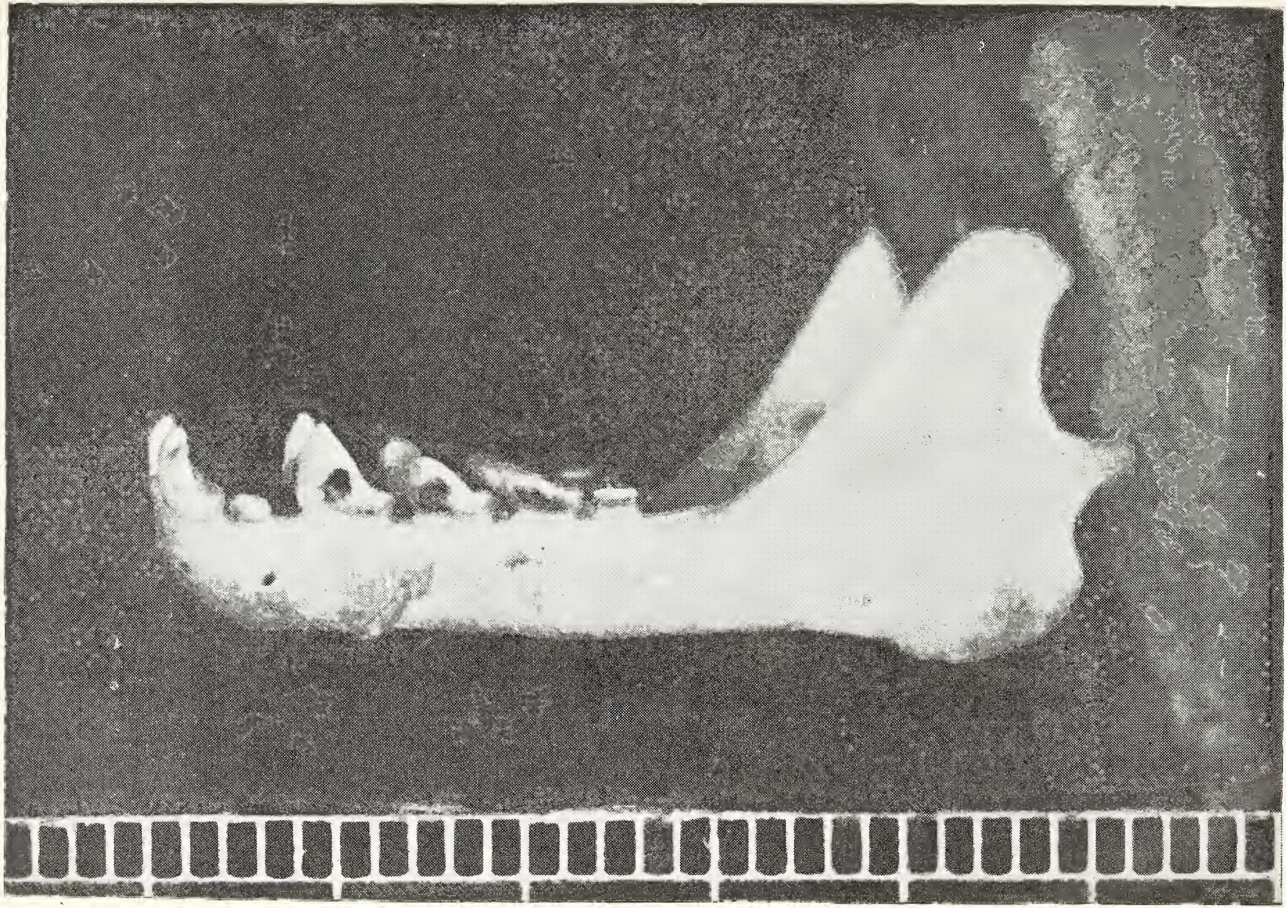
The bats listed by Hutton are :—

1. *Pteropus giganteus*
2. *Cynopterus sphinx*
3. *Scotophilus kuhli*
4. *Kerivoula picta*

Also he added, 'There are other bats in this area which I have not identified.' As he believed the new bat was a common species, he collected only a single specimen and does not have *Cynopterus sphinx* in his collection.

Ellerman & Morrison-Scott (1966, pp. 90-100) listed only 6 species of fruitbats among Pteropodinae known from India. Recently, Bhat (1968, pp. 471-473) added *Sphearias blanfordi* as the seventh species. *Latidens salimalii* is thus the eighth species of fruitbat known from India.

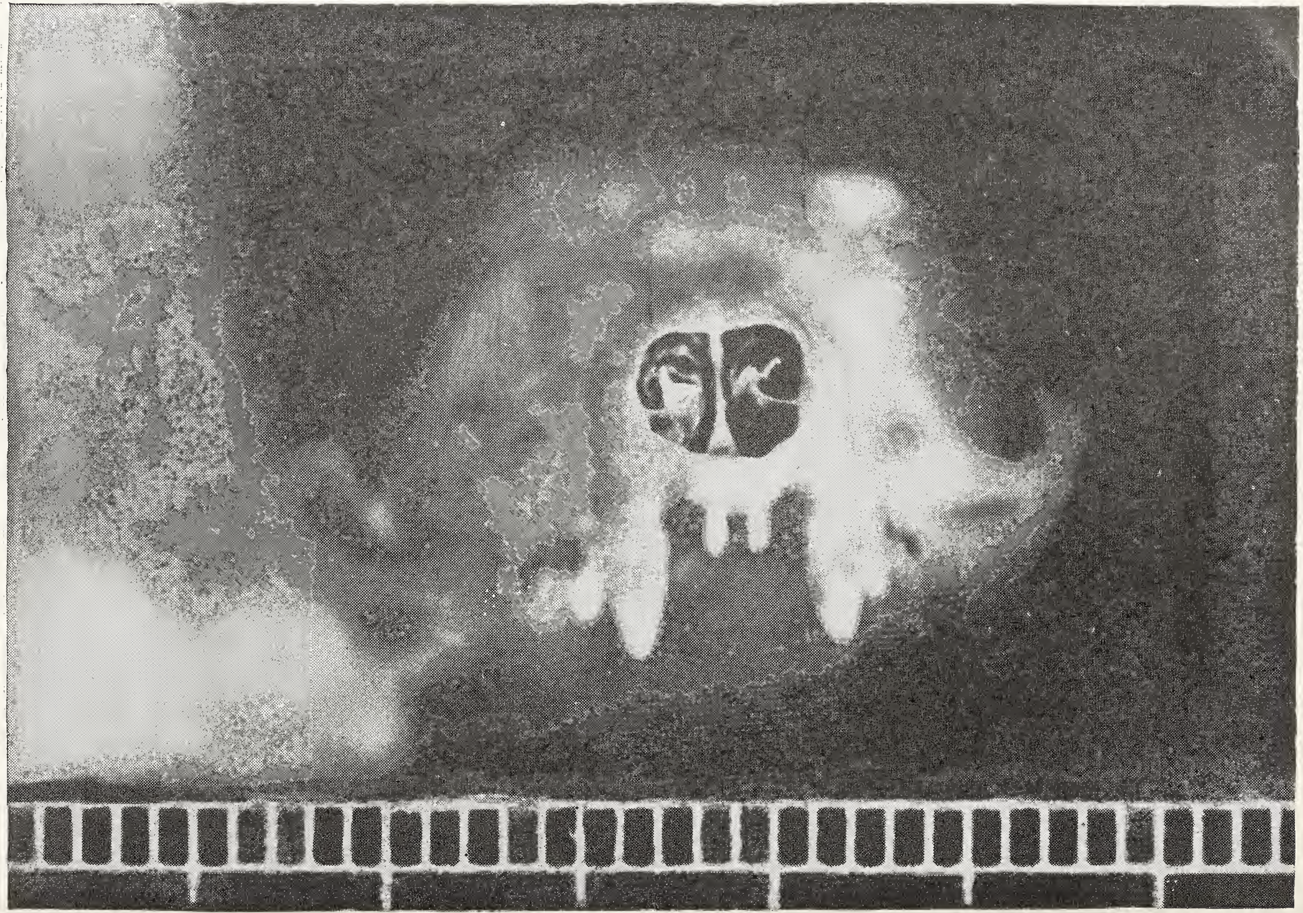
It gives me great pleasure to name this new bat after Dr. Sálim Ali, the well known ornithologist of the Bombay Natural History Society, who has devoted his life to the study of Indian Natural History.



Side view of the Mandible ×5

J. BOMBAY NAT. HIST. SOC. **69** (1) PLATE VI

Thonglongya : *Latidens salimalii*



Anterior view of the skull showing the upper incisors ×5

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr. S. Dillon Ripley and Dr. George E. Watson of the Smithsonian Institution who kindly arranged a grant for me to visit the Bombay Natural History Society where this new bat was discovered. Thanks are also due to Dr. Henry W. Setzer, Mr. Duane A. Schlitter of the Department of Mammals, Smithsonian Institution who gave me suggestions and replied to all my questions. I would like to express my deep indebtedness to Mr. John Edward Hill of the Mammal section, British Museum of Natural History for his useful criticism and suggestions and permission to use his comments in this paper. I am also indebted to Dr. Sálim Ali, Mr. Humayun Abdulali, and the Honorary Secretary and staff of the Bombay Natural History Society for their kindness and generous hospitality while I was in Bombay. I wish to thank Dr. H. E. McClure, Mr. Norman C. Wake, Dr. Prasert Lohavanijaya, and Air Vice-Marshal M. R. Sukshom Kashemsanta for their kindness and for reviewing the manuscript. I am indebted to Miss Apsorn Kaeo Amphon for typing the manuscript.

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Note added in proof

After the manuscript was sent to the publisher, another two genera, *Alionycteris* Kock (1969, *Sencken. Biologica*, **50** : 319-327), and *Otopteropus* Kock (ibid, pp. 329-338), were described recently. Hill (in litt.) wrote to me concerning these genera as follows :

" I have now compared *Latidens* with *Alionycteris* and *Otopteropus*. First of all there is no doubt at all that *Latidens* is quite distinct from either of these, and indeed, the further study that I have made reinforce my earlier conclusion that *Latidens* is most closely related to *Penthetor* and *Thoopterus*.

Alionycteris has the same tooth formula as *Latidens*, there being only one pair of upper and one pair of lower incisors. However, *Latidens* is very much larger, has the postorbital processes situated more anteriorly and its rostrum is wide anteriorly, not narrowed and slightly pointed as *Alionycteris*. The premaxillaries of *Latidens* project forward so that the incisors lie in front of the x canines, not in line with their anterior faces as in *Alionycteris*, and the posterior part of the post-dental palate in *Latidens* is relatively much narrower than in *Alionycteris*. The upper incisors of *Latidens* are not convergent or in contact at the tips as in *Alionycteris*, while pm 4/4 (The third premolar) and m 1/1 are square in basal outline and not rectangular as in that genus: m^1 in *Latidens* is large and not reduced and pm_4 and m_1 have a low surface cusp, not presented in *Alionycteris*. I have not yet attempted to elucidate the relationships of *Alionycteris* but at first examination it seems to belong with the small genera such as *Balionycteris* and its allies. Despite the tooth formula, it lacks the broadening of pm 3/3 (the second premolar) —m 1/2 (especially of pm 4/4—m 1/1) so characteristic of *Latidens*: other points such as the relatively wide post-dental palate, anterior narrowing of the mandible, reduction of m 1/1 and the shape of pm 3/3 support my suggestion that it belongs with the small genera. There seems no evidence to suggest close affinity with large genera such as *Penthetor*.

Otopteropus has the same incisive formula as *Latidens* but has lost m_2. Again, *Latidens* is very much larger and also lacks any conspicuous thickening on the anterior and posterior margin of the ear. The post orbital process of *Latidens* are situated more anteriorly, and although the rostrum of *Otopteropus* is wider anteriorly than that of *Alionycteris*, it is still relatively narrower anteriorly than the rostrum of *Latidens*. The premaxillaries of *Latidens* project anteriorly more than in *Otopteropus*, it has relative narrower postdental palate. Again, the upper incisors of *Latidens* are not convergent or in contact as in *Otopteropus*, pm 4/4—m 1/1 are square in basal outline and not rectangular, m 1/1 are not reduced and pm_4 and m_1 have a low surface cusp. As you may have gathered, *Otopteropus* and *Alionycteris* are very similar in most respects, and it seems that *Otopteropus* also belongs with the small genera. As with *Alionycteris*, its cranial and dental features resemble these of small genera rather than the large genera such as *Penthetor*, *Latidens* and *Thoopterus* ".

I am indebted to Mr. Hill for his kindness in permitting me to quote his comments.

K. T.

Studies in Cyperaceae—V. Novelties in *Fimbristylis* (L.) Vahl

BY

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(*With three plates*)

In the course of my work on the revision of the genus *Fimbristylis* for the whole of India, I came across certain novelties under this taxon and they are described as follows :

Fimbristylis latinucifera sp. nov.

Sect. *Fimbristylis*—Fig. 1

Perennis. *Rhizoma* brevissimum, indistinctum. *Culmi* fasciculati, erecti, trigoni vel triquetri, leves, sulcati, brunnei, denique nigrescentes, 10-20 cm × 0·8-1·2 mm. *Folia* pauca vel multa, basalia, brunnea denique nigrescentia, glabra, in dimidio superiore margine scabrida, ligulata, obtusa, culmo breviora vel aequalia, 10-20 cm × 1·2-2·4 mm ; vaginae glabrae, omnes laminiferae, supernis marginibus ferrugineis et hirsutis, ore oblique truncato. *Inflorescentia* capitata ad extremum culmum in fasciculum 1-3 capitum uno quoque capite consistente 4-12 spiculis, 1-2·5 cm longa et lata. *Bracteae* involucrales 2, in basali margine pilosae, insuperiore dimidio margine scabridae, tam longae vel longiores quam inflorescentia, 1·5-2 cm longae. *Spiculae* late ovoideae, acutae, teretes, sessiles, castaneae vel fuscae, fasciculatae, multiflorae, 5-7× 3-3·5 mm. *Rhachilla* distincte alata. *Glumae* late ovatae vel oblongo ovatae, acutae vel subacutae, erectae, chartaceae, spiraliter dispositae, interdum in superiore margine cum paucis capillis, plerumque in lateribus inerviae, castaneae, 3·2-3·6 × 2·4-2·6 mm ; carina distincta, 5-nervia ; nerves non excurrentibus vel leviter mucronem exiguum protractis, arcuata ; gluma infima vacua. *Stamina* 2 ; anthera acuta, 0·7 mm longa. *Stylus* planus, in dimidio superiore sparse fimbriatae, aliquantum latior, ad basin vix dilatata, 1·2-1·3 mm longus ; stigmata 2, fimbriata, stylo breviora, 0·6-0·8 mm longa. *Nux* insigniter lata, orbiculata vel napiformis, ad utrumque extremum attenuans, umbonulata, stipitata, laevis, biconvexa, tessellata, lutea vel brunnea, 1·3 (incl. stipite)×(1 –)

1·1 mm ; cellulae extimae in dimidio superiore distinctae, transverse oblongae vel hexagonales, in 12-14 regulares series in uno quoque latere.

Typus: Swamps 9 km. from Pykara, Nilgiris, *Bourne* 1430 *pro parte* (PCM, Herbarium of the Presidency College, Madras).

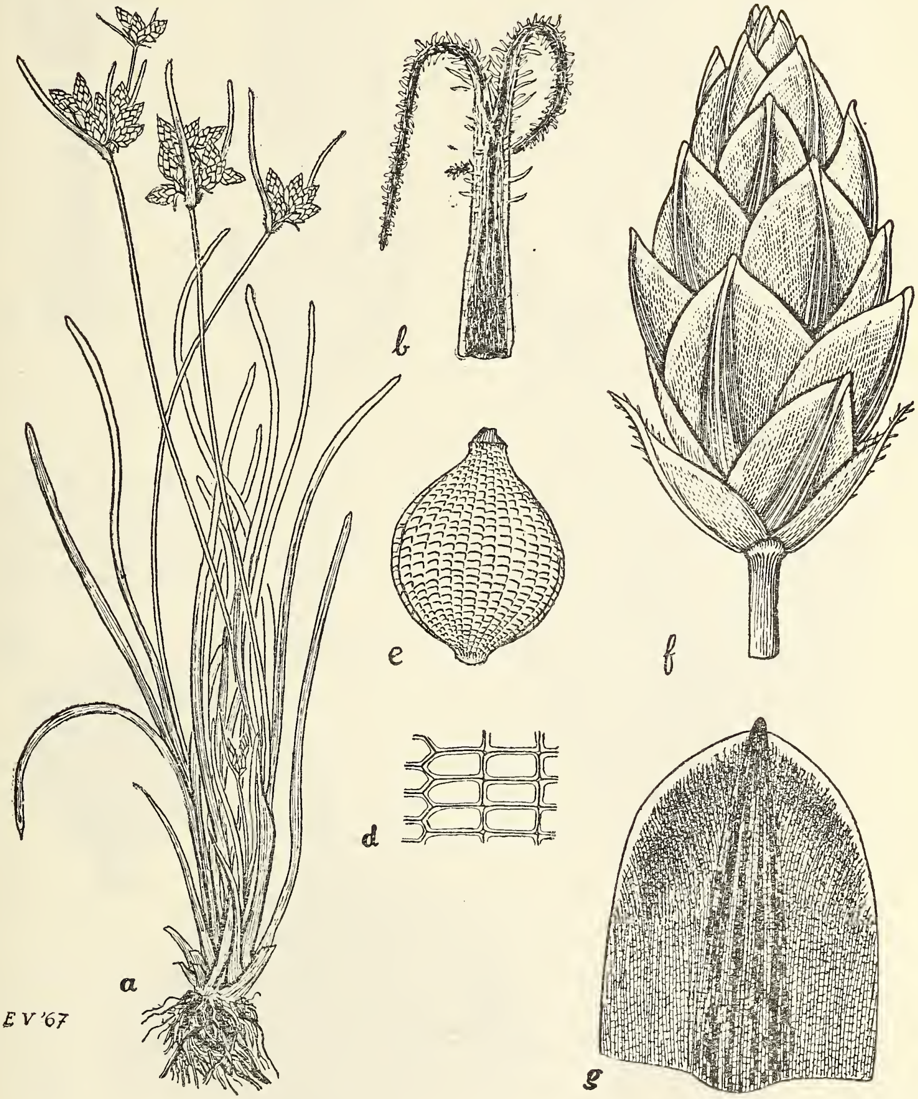
Note: Affinis *Fimbristylis dichotoma* (L.) Vahl, *s.l.*, sed differt quod habet folia ligulata, contractum inflorescentiam cum fasciculatis spiculis, spirales glumas, orbicula napiformes majores nuces habentes 12-14 series cellularum exteriorum super una quoque facie.

Fimbristylis latinucifera sp. nov.

Sect. *Eufimbristylis* Boeck.—Fig. 1

Perennial. *Rhizome* short, indistinct. *Culms* tufted, erect, trigonous, triquetrous, smooth, sulcate, brown finally becoming black, 10-20 cm × 0·8-1·2 mm. *Leaves* few-many, basal, brown finally becoming black, glabrous, scabrid in upper half, ligulate, obtuse, shorter or as long as the culm, 10-12 cm × 1·2-2·4 mm ; sheaths glabrous, all leaf bearing, with ferrugineous hirsutely hairy in upper margin, mouth obliquely truncate. *Inflorescence* capitate at the end of the culm, in a cluster of 1-3 heads, each head consisting of 4-12 spikelets, 1-2·5 cm long and broad. *Involucral bracts* 2, hairy in the basal margin, scabrid in upper half margin, as long as or longer than inflorescence, 1·5-2 cm long. *Spikelets* broadly ovoid, acute, terete, sessile, castaneous-fuscus brown, clustered, many-flowered, 5-7×3-3.5 mm. *Rhachilla* distinctly winged. *Glumes* broadly ovate-oblong ovate, acute-subacute, erect, chartaceous, spiral, sometimes with a few hairs in upper margin, usually nerveless on the sides, castaneous brown, 3·2-3·6 × 2·4-2·6 mm ; keel distinct, 5-nerved ; nerves non-excurrent or slightly produced into a minute mucro, curved ; basal glume empty. *Stamens* 2 ; anther acute, 0·7 mm long. *Style* flat, sparsely fimbriately hairy in upper half, rather broad, hardly dilated at base, 1·2-1·3 mm long ; stigma 2, fimbriately hairy, shorter than style, 0.6-0.8 mm long. *Nut* conspicuously broad, orbicular-napiform, attenuating at both ends, umbonulate, stipitate, smooth, biconvex, tessellated, yellow-brown, 1·3 (incl. stipe) × (1 –) 1.1 mm ; outer cells in upper half distinct, transversely oblong-hexagonal, in 12-14 regular rows on each face.

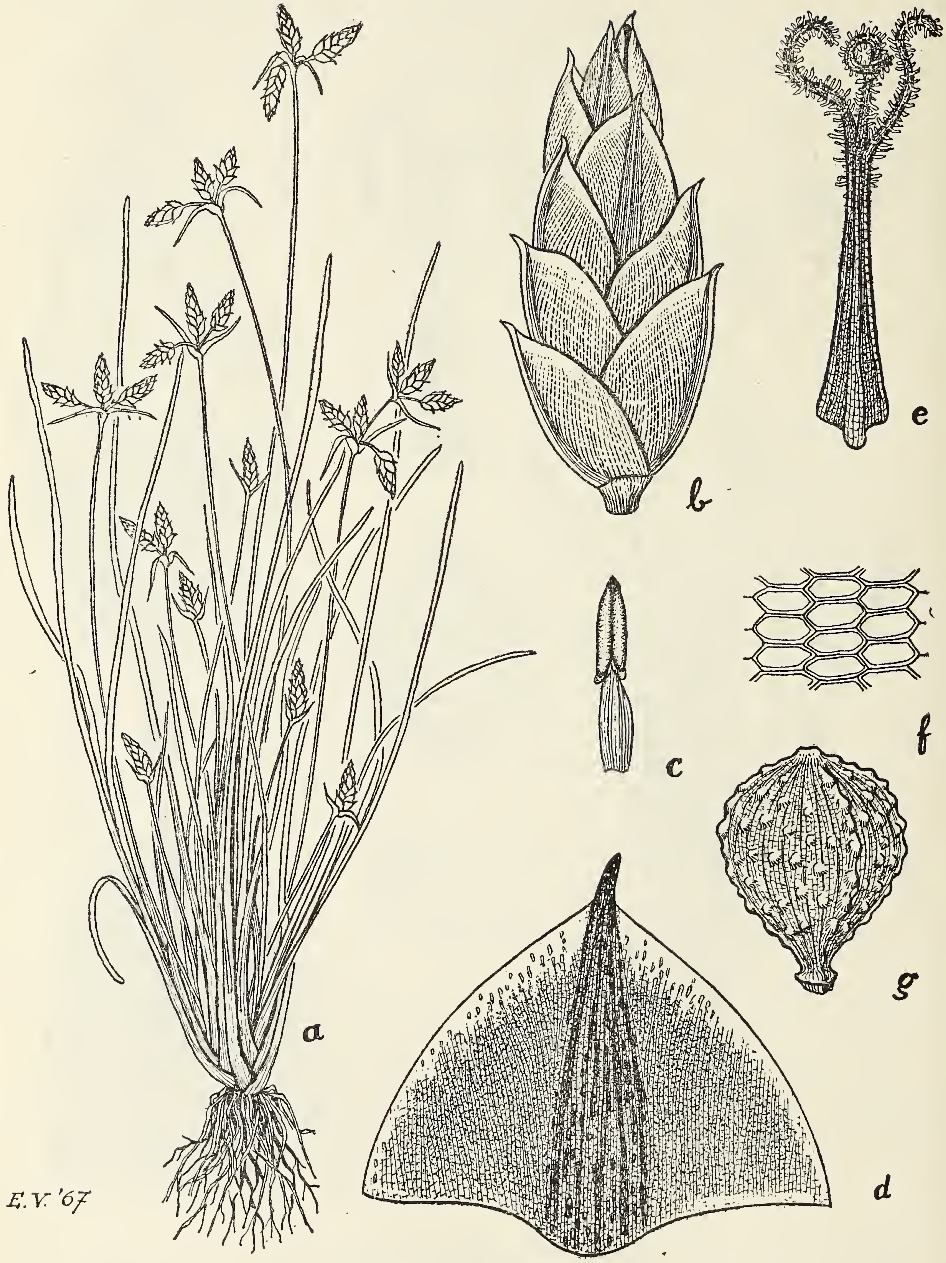
Note: Related to *Fimbristylis dichotoma* (L.) Vahl, *s.l.* but differs in having ligulate leaves, contracted, capitate inflorescence with clustered spikelets, spiral glumes, orbicular-napiform conspicuously larger nuts having 12-14 regular rows of outer cells on each face.



Fimbristylis latinucifera sp. nov.

a. Habit × 3/8 ; b. style and stigmas × *c*.8 ; d. outer cells of nut (diagrammatic) ; e. nut × *c*.8 ; f. spikelet ×*c*.4 ; g. glume ×*c*. 6—(from *Bourne* 1430 *p.p.*).

Note : The seed sketch *e.* is inverted.



Fimbristylis latiglumifera sp. nov.

a. Habit × *c.* 2/3 ; b. spikelet × *c.*7 ; c. stamen × *c.*21 ; d. glume × *c.*14 ; e. style and stigmas × *c.*21 f. outer cells of nut (diagrammatic) ; g. nut × *c.*14—(from *Nirmala Maharaj* 349).

Fimbristylis latiglumifera sp. nov.

Sect. *Tenerae* Kern, *sect. nov.*—Fig. 2

Perennis. *Rhizoma* brevisimum, indistinctum cum internodis abbreviatis. *Culmi* 1-3, fasciculati, ad basin foliati, triquetri, tripteri, glabri, straminei-virides, subgraciles, erecti, costati, sculcati, in dimidio superiore scabridi, 8-16 cm × 0·6-0·7 mm. *Folia* pauca, erecta vel curva, anguste, linearea, in marginibus scabra, eligulata, acuta vel acuminata, 7-9 nervia, culmo breviora, 5-12 cm × 0·6-0·8 mm ; vaginae infimae 1-2 foliorum expertes, glabrae cum lateribus membranaceis hyalinis, brunneae, non corneae, ore oblique truncato. *Anthela* simplex, umbella contracta, constans (1–) 3 (–4) spiculis, patens, 6-7 × 8-15 mm. *Bracteae* involucrales anthela breviores, setaceae, glabrae, 4-5 mm longae. *Spiculae* ovatae, acutae, subteretes, flavobrunneae, 8-12 floribus, subpedicellatae, 5 mm longae, accrescentes demum usque ad 8 mm, 2 mm latae. *Rhachilla* alata, excavata. *Glumae* late deltoido-ovatae, acutae, integrae cum angusta hyalina margine, ad apicem glabrae, lateribus enerviis, concavae, adpressae, erectae, eglandulosae, nitideae, flavo-ferrugineo brunneae, chartaceae, 2-2·5 × 2·5-2·7 mm ; mucro recurvates, 0.2 mm longus ; carina viridis, valida, 5 nervia ; nervis in mucronem excurrentibus ; cellulae angustae, longitudinaliter oblongae, plus minusve erectae ; glumae inferiores 2, vacuae. *Stamina* 3 ; anthera oblonga vel elliptica, brunnea, minute apiculata vel obtusa, ad basin minute calcarata, 0·3-0·35 mm longa. *Stylus* triquetrous cum basi pyramidali leviter dilatata, sparse fimbriatus post trifurcationem, 1-1·2 mm longus ; stigmata 3, fimbriata, stylo breviora, 0·7-0·8 mm longa. *Nux* obovoidea, fusca vel nigra, globosa trigona cum lateribus convexis, tricostata, minute stipitata, umbonulata, dense tuberculata, ad apicem rotundata, 1 × 0·8 mm ; cellulis extimae in dimidio superiore distinctae, transverse oblongae vel hexagonales, in series longitudinales 8-10 regulares in uno quoque latere.

Typus : Nilgiris, *Nirmala Maharaj* 349 (PCM).

Note : Affinis *Fimbristylis obtusata* Ridley sed differt quod habet habitum perenum, linearia, longa, acuto-acuminata folia, fere sessiles spicules, latiores glumas, 3-stamina, pilosum stylum et stigma et majores nuces habentes 8-10 regulares series cellularum exteriorum super singula facie.

Fimbristylis latiglumifera sp. nov.

Sect. *Tenerae* Kern, *sect. nov.*—Fig. 2

Perennial. *Rhizome* short, indistinct with short internodes. *Culms* 1-3, tufted, leafy at base, triquetrous, tripterous, glabrous, stramineous-green, rather slender, erect, ribbed, sulcate, scabrid in upper half,

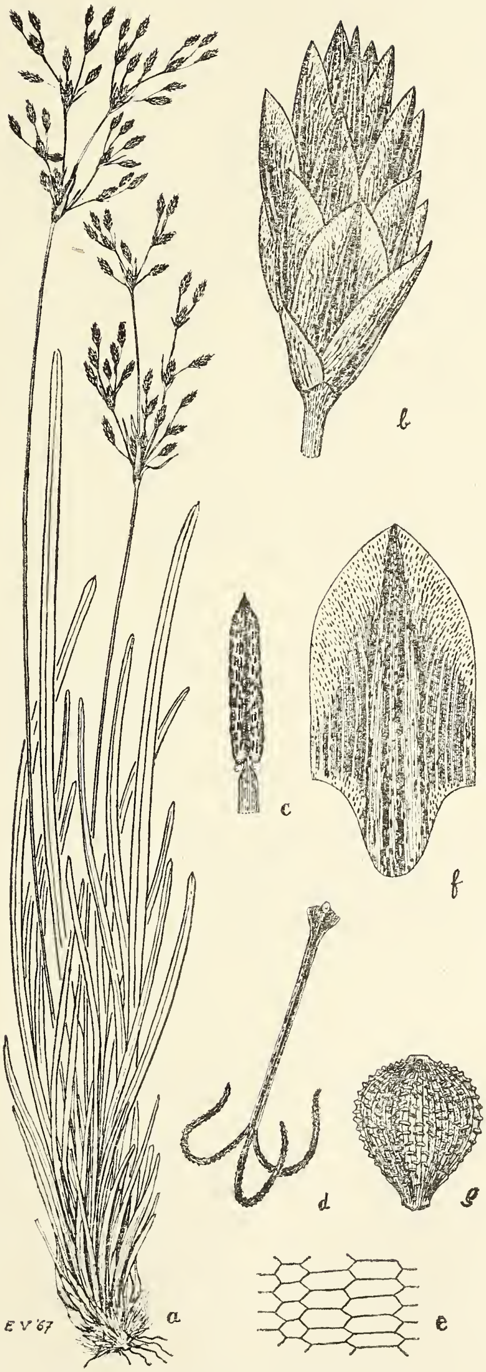
8-16 cm × 0·6-0·7 mm. *Leaves* few, erect-curved, narrow, linear, scabrid in the margin, eligulate, acute-acuminate, 7-9 nerved, shorter than culm, 5-12 cm × 0·6-0·8 mm ; sheaths lowermost 1-2 leafless, glabrous, with membranous hyaline sides, brown, non-horny, mouth obliquely truncate. *Anthela* simple contracted umbel, consisting of (1–) 3 (–4) spikelets, spreading, 6-7 × 8-15 mm. *Involucral bracts* shorter than anthela, setaceous, glabrous, 4-5 mm long. *Spikelets* ovoid, acute, subterete yellowish brown, 8-12-flowered, subpedicellate, 5 mm long, lengthening, up to 8 mm, 2 mm broad. *Rhachilla* winged, excavated. *Glumes* broadly deltoid-ovate, acute, entire with narrow hyaline margin, glabrous at apex, sides nerveless, concave, adpressed, erect, eglandular, shining, yellowish-ferrugineous brown, chartaceous, 2-2·5 × 2·5-2·7 mm ; mucro recurved, 0·2 mm long ; keel green, strong, 5-nerved ; nerves excurrent into mucro ; cells narrow, vertically oblong, more or less straight ; basal glumes 2, empty. *Stamens* 3 ; anther oblong or elliptic, brown, minutely apiculate-obtuse, minutely spurred at base, 0·3-0·35 mm long. *Style* triquetrous with slightly dilated pyramidal base, sparsely fimbriately hairy behind trifurcation 1-1·2 mm. long ; stigma 3, fimbriately hairy, shorter than style, 0·7-0·8 mm long. *Nut* obovoid, fuscus brown-black, globosely trigonous with convex sides, tricostulate, minutely stipitate, umbonulate, densely tubercled, rounded at apex, 1 × 0·8 mm ; outer cells in upper half distinct, transversely oblong-hexagonal, in 8-10 regular vertical rows on each face.

Note: Related to *Fimbristylis obtusata* Ridley but differs in having perennial habit, linear, long, acute-acuminate leaves, almost sessile spikelets, broader glumes, 3 stamens, hairy style and stigmas and larger nuts having 8-10 regular rows of outer cells on each face.

Fimbristylis multinervia sp. nov.

Sect. *Trichelostylis* (Lestib.) Boeck.—Fig. 3

Perennis. *Rhizoma* brevissimum, incrassatum, ligneum, obliquum, filis inflexis vaginae fibrosis circumdatum. *Culmi* fasciculati, tetragoni, rigidi, erecti, glabri, leves, prominenter multicostati, sulcati, ad basin foliati, et crassi et lignosi, 20-45 cm × 2·3-2·5 mm. *Folia* glauca vel brunnea, glabra, ligulata, serrate-scabrida in margine, obtuse vel abrupte acuta ad apicem, plana, cum incrassata margine, 35-45 nervia, folia caulino pauca, crescentia usque ad 4-5 nodos, brevia, 2-10 cm × 2·4 mm ; folia surculorum sterilum carinata, fere aequalia culmo, 3-5 mm lata ; vagineae omnes foliferae, pallidae, plus minusve corneae, crassae, glabrae cum margine brunnea, angusta, membranacea, hyalina, ad apicem glabrae, ore transverse truncatae. *Anthela* composita imo supradecom-



Fimbristylis multinervia sp. nov.

a. Habit × 1/4 ; b. spikelet ×*c*.5 ; c. stamen × *c*.15 ; d. style and stigmas × *c*.9
e. outer cells of nut (diagrammatic) ; f. glume × *c*.9 ; g. nut× *c*.9—(from *Kurz* 637).
Note : Sketch *d.* is inverted.

posita, paten's, laxa cum 20-50 spiculis, 5-10 cm longa et lata. *Bracteae involucrales* foliaceae, erectae, per totum serrate-scabridae, non asperae, anthela breviores (2-) 4-6 cm × 2-3 mm. *Radi* primarii 4-8, leves, 1-10 cm longi. *Spiculae* ovoidae vel lanceolatae vel ellipsoidae, acutae vel subacutae, subteretes, fuscae, solitariae, pedunculatae, multiflorae, 6-6·5 × 2·2-2·7 mm. *Rhachilla* alata, excavata. *Glumae* oblongo-ovatae, oblique erectae, in dimidio superiore anguste hyalinae et interdum ciliatae ad basin valde arcuatae, obtusae, laxae, glandulosae, nitidae, dense tanniniferae, conduplicatae, pelrumque muticae, multinerviae, (6-13 nervis in uno quoque dimidio), 3-3·5 × 1·3-1·5 mm ; carina valida, 3-nervia, arcuata ; cellulae angustae, longitudinaliter oblongae, marginem versus arcuatae; glumae inferiores 1-2, vacuae. *Stamina* 3 ; anthera purpurea, lineari, apiculatae, ad basin lobata, 1·3-1·4 mm longa. *Stylus* triquetrous, tenuis, glaber cum basi pryamidali late dilatata, 1·3-1·4 mm longa ; stigmata 3, tenues, papillosa, stylo breviora, 1-1·2 mm longa. *Nux* late obovoida vel obcordata, vix umbonulata, plerumque sessilis, obtuse trigona, tricostulata cum lateribus convexis vel planis, dense tuberculata, 1·3-1·4 × 0·9-1 mm ; cellulae extimae in dimidio superiore breviter et transverse hexagonales in 10-14 regulares series in uno quoque latere striatae.

Typus: Karen country Hills, Jonkeyeghat, Pegu, Burma (not Birma), *S. Kurz* 637 (CAL) ; Paratypi : Jonkeyeghat, Pegu, 7 Pagodas, Burma, *S. Kurz* 628, 636 (CAL) ; Pegu, *D. Brandis* 1018 (CAL) ; Leve Kohima, Naga Hills, (alt. 1300 m.), *Dr. D. Prain* 226 (CAL) ; Upper Burma, *J. C. Prazer, s.n.* (CAL) ; Pegu, without collector's name 2 (CAL).

Note:—Affinis *Fimbristylis thomsonii* Boeck. sed differt quod habet laeves culmos, multinervia folia, longiores non asperos bractes, multiflores spiculas, dense tanniniferes, oblique erecta, multinervia glumas, dense tuberculatas nuces, habentes minorem numerum seriarum cellularum exteriorum super una quoque facie.

Fimbristylis multinervia sp. nov.

Sect. *Trichelostylis* Boeck.—Fig. 3.

Perennial. *Rhizome* short, thick, woody, oblique, covered by fibrous strands of the sheaths. *Culms* fascicled, tetragonous, rigid, erect, glabrous, smooth, prominently many ribbed, sulcate, leafy at base, thick and woody, 20-45 cm × 2·3-2·5 mm. *Leaves* glaucous-brown, glabrous, ligulate, serrately scabrid in the margin, obtuse or abruptly acute at apex, flat with thickened margin, 35-45 nerved, cauline leaves few developing upto 4-5 nodes, short, 2-10 cm×2-4 mm ; leaves of sterile shoots keeled, nearly as long as culms, 3-5 mm broad ; sheaths

all leaf bearing, pale, more or less horny, thick, glabrous with brown, narrow, membranous, hyaline margin, glabrous at apex, mouth transversely truncate. *Anthela* compound-supradecompound, patent, lax, consisting of 20-50 spikelets, 5-10 cm long and broad. *Involucral bracts* leaf like, erect, scabrid-serrate throughout, non-asperous, shorter than anthela, (2–) 4-6 cm × 2-3 mm. *Primary rays* 4-8, smooth, 1-10 cm long. *Spikelets* ovoid-lanceolate-ellipsoid, acute-subacute, subterate, fuscus brown, solitary, peduncled, many flowered, 6-6·5×2·2-2·7 mm. *Rhachilla* winged, excavated. *Glumes* oblong-ovate, obliquely erect, narrowly hyaline in upper margin and sometimes ciliate with strongly curved base, obtuse, lax, glandular, shining, densely tannin bearing, conduplicate, usually muticous, many nerved (6-13 nerves in each half), 3-3·5×1·3-1·5 mm ; keel strong, 3-nerved, curved ; cells narrow, vertically oblong, curving towards margin ; basal glumes 1-2, empty. *Stamens* 3 ; anther purple, linear, apiculate, lobed at base, 1·3-1·4 mm. *Style* triquetrous, slender, glabrous with broadly dilated pyramidal base, 1·3-1·4 mm long ; stigma 3, slender, papillate, shorter than style, 1-1·2 mm long. *Nut* broadly oboviod-obcordate, hardly umbonulate, usually sessile, obtusely trigonous, tricostulate with convex or flat sides, densely tubercled, 1·3-1·4 × 0·9-1 mm ; outer cells in upper half shortly and transversely hexagonal in 10-14 regular rows on each face.

Note:—Related to *Fimbristylis thomsonii* Boeck. but differs in having smooth culms, many nerved leaves, longer, non-asperous bracts, many flowered spikelets, densely tanning bearing, many nerved obliquely erect glumes, densely tubercled nuts possessing lesser number of rows of outer cells in each face.

ACKNOWLEDGEMENTS

I express my deep sense of gratitude to Z.W.O. Foundation, the Netherlands, for having given me the opportunity to undertake the present revision work at Rijksherbarium, Leiden. I also thank Mr. Vysma for the preparation of the figures and Dr. J. H. Kern for the interest shown in this work.

Reviews

1. ECOLOGICAL ISOLATION IN BIRDS. By David Lack, F.R.S. 404 pp. (14×21·5 cms). Main illustrations by Robert Gillmor. London, 1971 (Blackwell). Price £4·25 net.

Gause's Principle, more descriptively termed Competitive Exclusion, postulates that closely related or congeneric species taking identical food cannot coexist in a homogeneous habitat. The operation of this principle among birds as revealed by the analytical study of certain groups and families of tropical, subtropical and temperate regions, especially on oceanic islands and archipelagoes where the complexity of factors is comparatively reduced, forms the burden of this book. To enable closely allied species to coexist in the same habitat they must have developed through natural selection special adaptations, either morphological (such as diversity in overall size or size of bill and other parts) or ecological (such as food, feeding behaviour, feeding and breeding stations, and other forms of isolation) which resulted in removing direct competition between them. On remote islands any new arrival must complete immediately with established species. If it fails it must die out, therefore suitable adaptations must evolve quickly. How even minor ecological differences may bring about radical changes in structure and function (e.g. of bill) and produce Adaptive Radiation was lucidly shown by Lack 25 years ago in the case of Darwin's finches in the Galapagos. Since then research on other species coexisting in a variety of environments in different parts of the world has further helped to establish the general relevance of the principle of ecological isolation.

Among the many examples cited in the book, the tits of the genus *Parus* and the nuthatches (*Sitta*) are two of the better studied and analytically documented groups in regard to the problem of coexistence. The White-eyes (family Zosteropidae), which has spread to and colonized remote tropical islands, also provides numerous examples of ecological isolation in the several subspecies of congeneric species that coexist on many of them, segregated from each other by range, habitat, altitude or size (and presumably by feeding behaviour or food) or combinations of some of these criteria. Separation by size, or by size of bill, is common in island birds and especially within this widespread family.

The 30 appendices give fuller details of the congeneric and closely related species treated in the 14 chapters which comprise the book, and a review of the geographical segregation, habitat restriction, food and other factors responsible for their ecological isolation on island and mainland areas in different parts of the earth.

This is a stimulating and thought-provoking book which should find a place in the library of every ornithologist and serious bird-watcher. It offers cues to the many possibilities for fruitful field research in India, as in other tropical and subtropical regions, where, due to the richness of the avifauna and diversity of the habitats the opportunities for studying ecological relationships among coexisting species are so lavish. One example, on our own doorstep, that immediately springs to mind is the babblers of the genus *Turdoides*. Two, or sometimes three, species may often be found living side by side in a single homogeneous habitat, and a different pair of species (or a different combination) in an adjacent habitat superficially identical, *apparently* without directly competing. The adaptations—morphological, behavioural, dietary or other—that make their coexistence possible need to be investigated and identified in the context of the principle of Competitive Exclusion.

S. A.

2. THE CONTROL OF INJURIOUS ANIMALS. By J. M. Cherrett, J. B. Ford, I. V. Herbert, and A. J. Probert. pp. xiv+210 (21.5×13 cm.). Biological Science Texts. London, 1971. The English Universities Press Ltd. Price £1·65 net.

This book has been written for students interested in control technique. And since chemical pesticides now a days occupy a prominent position in control work, its pages are plentifully strewn with the chemical formulae of the principal pesticides used. It would be a mistake, however, for the layman to let this fact frighten him away, as the book has much that is interesting and useful to tell him. It is amazing, the amount of research that goes into the formulation of the various pesticides, and the problems the research worker has to face, problems which may mean that by reason of some unexpected reaction his particular bit of research work may have to be scrapped. And after the formulation, the pesticide has to be applied at the time and in the manner that best serves the worker's purpose. Applied at a time when some natural controlling factors are at work, it may actually make the situation worse. Or by eliminating some such factors it may give free scope to a hitherto unnoticed pest.

Throughout, the authors impress on their readers the dangers inherent in the employment of this method. Particularly to be feared is the development of resistance; it is interesting that the authors conclude on the note that pest control today is in a transitional stage and it is difficult to envisage what the long-term pattern will be.

D. E. R.

3. THE WORLD OF THE JAGUAR : By Richard Perry. pp. 168 (22×14·5 cm); with 3 maps and 12 plates. Newton Abbot, Devon, U.K., 1970. David & Charles (Publishers) Ltd., Price £2·25 (45*s.*) net.

The author known for his 'World' series of books on the tiger, the polar bear, the giant panda, and the walrus and for other books has brought together in this modest volume the available information on the little-known jaguar, which is revered in South and Central America as the tiger is in Asia. Like the tiger, the jaguar is regarded as a symbol of the jungle, of the cunning and ferocity and incredible strength and beauty of raw Nature. The modest compass of the book, compared to over 250 pages of the author's THE WORLD OF THE TIGER shows the woeful lack of reliable data regarding the jaguar. The topics dealt with in the chapters of the book relate *inter alia* to the country of the jaguar, the jaguar's prey, jaguar hunting, jaguar and men ; these and especially the chapter on jaguar fishing will be of particular interest to Indian readers including those who may be tempted to compare the tiger with the jaguar which is known as 'water tiger'. The relations of the jaguar with anacondas and with giant reptiles as well as other neighbours are narrated in some details, and there is a chapter on supernatural jaguars, since the jaguar's hold over men's mind and beliefs is said to surpass in its universality that of the tiger in India. It is reassuring to find that though the jaguar's range has contracted somewhat, the animal has not suffered the fate of the cats of the Old World, because man has not yet penetrated vast areas of the South American hinterland.

Owing to inadequacy of data, the author has found himself unable to provide an assessment of the present status and future prospects of the jaguar ; but it is sad to note that there is already disturbing evidence of excessive hunting pressures in areas lying within thirty miles of the major river highways. Trade in jaguar skins is said to thrive on account of the high price realised (around Rs. 13,000 per skin) in the South American fur markets. It is to be hoped that the jaguar which appears to be as wonderful as the tiger will continue to live in the remote areas of Central and South Americas without interference by man, and will provide an interesting subject for further studies.

The book contains some beautiful photographs, reproduced by courtesy of Bruce Coleman Ltd., and there are appended to the book a glossary of scientific names of animals and a bibliography containing about a hundred titles. The author deserves thanks of naturalists for presenting the available material, albeit inadequate, about the jaguar in this volume. The book shows clearly how animal behaviour is affected by environment and how superstitions build up regarding the unknown.

G. V. B.

4. FOREST FLORA OF GUJARAT STATE. By R. I. Patel. pp. ii+381 (15×10·5 cm.). Baroda, 1971. Forest Deptt., Gujarat State. Price Rs. 12.50.

The general image of a forester in the public mind is that he is the closest to nature and is the enlightened link between a layman and our natural flora and fauna. Does he fit this public image in the present day? He seems to be under an unbearable burden of the complexities of administration in our young democracy. If foresters are ever going to prepare themselves for the uphill task of conservation of nature, the philosophy of forestry will have to be changed. In the new context each floristic element in a forest has its own niche and cannot be ignored except at the risk of destroying our heritage. The present-day forester, with a few exceptions, cannot recognise as many elements of the flora as his predecessor two generations ago. One would readily join Principal M. B. Raizada (Retd. Forest Botanist) in hoping that this publication will revive the healthy trend of the past (a colleague fears that it may be a swansong!).

Incidentally, it has always intrigued me what constitutes a forest flora! The only apparent criterion so far applied is that a floristic work prepared by a forester should be called FOREST FLORA. A forester can exclude plants on which he treads or which stare at him for a part of the year because they do not deserve a place in his working plan.

This pocket-book reflects the author's intense interest in its production. It mentions about 600 indigenous and introduced species under 83 families and 297 genera in the forests of Gujarat. Each species is represented by its scientific name and important references, a short descriptive note, local names in Gujarat, and months of flowering and fruiting.

If a family contains more than one genus or a genus more than one species, an appropriate key is provided to help correct identification of a species. Indices to scientific and local names are appended.

On the whole it is a useful compilation in a convenient and concise form listing a majority of forest flora of Gujarat. It is certainly a good working list for foresters, and students of Botany of Gujarat State. Perhaps it is to keep the book in handy size that the author has desisted from giving quantitative data re: the economics of productivity of various important species which must be available to him as a senior forest officer of Gujarat State. One hopes that it will be possible to give such information in another edition of this valuable pocket-book. Students of Botany quite often do not get a true picture of the economics of forestry in their text-books.

Besides the economics, the place of forests in conservation of nature and human ecology is incalculable and any publication that gives facts of forest wealth is most welcome in the present context. This reviewer sincerely feels that this publication should be translated in local language for the benefit of those who are not conversant with the English language.

P. V. B.

5. INDIAN INSECT LIFE : A MANUAL OF THE INSECTS OF THE PLAINS (TROPICAL INDIA). By H. Maxwell-Lefroy, assisted by F. M. Howlett. pp. xii+786 (22×15 cm.). With numerous coloured plates and black-and-white illustrations. Reprint. New Delhi, 1971. Agricultural Research Institute, Pusa.

Student and layman alike will welcome the reappearance of Maxwell-Lefroy's INDIAN INSECT LIFE, a photo-offset of which has been published by the Agricultural Research Institute, Pusa. The original has long been out of print. There is nothing quite like INDIAN INSECT LIFE in India. The numerous excellent illustrations cover almost all the common insects one is likely to encounter in the plains of India, making identification, at least to the family if not the genus and species, easy. Habits and life histories are included as known in 1909. The black-and-white illustrations have reproduced very well. Some of the beautiful coloured plates are rather smudged, but are still clear enough for the identification of the insects illustrated.

Good as it is to have this valuable book available again outside reference libraries, it is sad that nothing has been published in the last sixty-two years to supersede it. In his foreword to the first edition Maxwell-Lefroy himself apologised for his book's imperfections and expressed the hope that it would serve as a stepping stone for something better. Since then a tremendous amount of research has been done at the Agricultural Research Institute, Pusa, at the Forest Research Institute, Dehra Dun, and at other Indian institutions. The need is for a revised edition of INDIAN INSECT LIFE, which incorporates new information and brings the scientific names up-to-date. This requires to be done with skill. It was Maxwell-Lefroy's excellent judgement in including only the essential and interesting that made the book the classic it is. I hope that one of our many distinguished entomologists will accept the challenge.

R. R.

6. LIFE WITH DAKTARI. By Susanne Hart. pp. 224 (21·5×14 cm.) With 40 plates. London, 1969. Bles/Collins. Price 36*s*. net.

Readers of Joy and George Adamson's books will remember the Harthoorns, a husband and wife team of vets called in at various times to look after their animals. This book by Susanne Harthoorn is an account of what life in East Africa is like for a pair of vets devoted to wild life. Her husband Toni is one of the pioneers of the immobilisation of large wild animals with tranquillising drugs, a technique with great possibilities for treatment and research. One of the most exciting parts of the book is the description of the darting of a wild elephant and the fitting onto it of a collar with various instruments on it. The operation involved considerable risk; African elephants have been known to attack vehicles. There were other difficulties also. The dose of tranquilliser might not be large enough, or by the time it took effect the animal might be where it could not be got at. One darted elephant went down in the middle of the herd, and the team witnessed the amazing sight of a stamping, screaming herd of elephants trying to raise their fallen comrade and surrounding him till he recovered two hours later.

The description of an operation on a semi-wild lion's eye and the occasion on which Mrs. Harthoorn walked up to a young giraffe, spoke to him and injected him without any restraint whatsoever show her to be a remarkable woman. One wishes she would tell us more about the animals, whales for example. Dr. Harthoorn was asked to take part in an attempt to immobilise and mark whales; we are not told anything about the difficulties involved, nor whether the operation was successful. One would like to know more about the 'Animal Ark' venture. It was no mean feat to capture the interest and imaginations of young African and Asian children, and to answer their unrehearsed questions about animals.

There are inaccuracies. Taga was a female leopard cub, and Arun Sharma has been transformed into Aaron Sharma. A picture of Sam, one of Girl's first litter, is captioned so as to suggest that it belongs to a later period when Girl settled down to become a good mother.

R. R.

7. THE ROE DEER OF CRANBORNE CHASE. By Richard Prior. pp. 208 (22 × 14 cm), with 16 plates and 42 text-figures, London, 1968. Oxford University Press. Price. 50*s*. net.

Books on scientific management of wild deer, especially of single species, are not many. Richard Prior's latest contribution on the Roe

Deer (*Capreolus capreolus*) in a part of England, Cranborne Chase, formerly an extensive royal hunting preserve, now reduced to about 5,000 acres in North Dorset, is a valuable addition to the literature.

Roe is indigenous to England and occurs in wooded areas. Being mainly a browser, the roe causes extensive damage to forest plantations. Also, the bark of young trees, red oak in particular, is stripped off by the 'fraying' of bucks in their attempt to mark territory; this again causing appreciable damage to forest wealth. In the absence of a large predator species in England which could be relied upon to effectively check the population's growth of roe, culling of bucks other than those in prime condition and with definite territories was thought to be the only solution. Effective culling without endangering the survival of the species could be carried out only after a thorough ecological survey of the Roe populations. With the view to obtain necessary data for better roe deer management techniques, Mr. Prior studied intensively the roe in the following two sample areas—Verndítch Chase (312 acres) and Stonedown Wood (270 acres) over a period of four years.

The census technique adopted for the work with notes on age determination, population structure and density at different periods of an year, determination of roe buck territories, culling methods are all discussed in the later pages of the book in detailed and unambiguous terms. The earlier chapters provide the background information about the roe such as weight, pelage, antlers, food preferences, the rut, fawning etc., and about the study area necessary for understanding the later pages. Detailed information on some parasites and diseases of roe deer in Cranborne Chase written by Dr. A. M. Diarmid, a veterinarian, is appended to the text.

The book is an excellent, methodical field study record, and presents a wealth of information on a difficult subject in a lucid, interesting manner. It is very readable because it avoids scientific jargon and limits descriptions of complicated field study techniques to the essential features. The book should be a required reading for all persons directly concerned with the survival of deer in Indian sanctuaries and parks. Selective adoption of field study techniques practised by the author is strongly recommended. As general reading, the book should be of interest and acceptable to all conservationists.

P. KANNAN

Miscellaneous Notes

1. OCCURRENCE OF *RHINOPOMA HARDWICKEI* GRAY, 1831, THE LESSER RAT-TAILED BAT IN A HUMID AREA OF COASTAL MYSORE

Brosset (1962)[1] in his study of the bats of Central and Western India recorded *Rhinopoma hardwickei* Gray, 1831, the Lesser Rat-tailed Bat from 16 localities, all of them considered to be arid or semi-arid. This observation, and the known distribution of the species in the arid Middle East led Brosset to conclude that this species is associated with xerothermic conditions. The species has not so far been recorded from the Western Ghats, Konkan and Kanara, which receive heavy rainfall and remain humid throughout the year. Brosset (1962) has ruled out its occurrence in this area. Contrary to his statement the present record brings coastal Mysore under its distribution range in India.

During a recent survey of bats in connection with the epidemiological investigations of Kyasanur Forest disease, a colony of *Rhinopoma hardwickei* was located in a cave, right at the sea coast, at Gokarna, North Kanara District, Mysore State, on March 26, 1971. The locality receives an annual rainfall of approximately 350 cm. About one hundred individuals were found inhabiting a natural underground cave in laterite rock. The cave is locally known as 'Gogarbha'. It is approximately 15 m×6 m×2·5 m in dimension with a couple of large lateral excavations and a dozen smaller pockets. When visited in the morning the climate inside was warm and extremely humid. Four specimens, all of them males, were collected for identification. Other species of bats in the same colony associated with *Rhinopoma hardwickei* were *Hipposideros speoris*, *Hipposideros bicolor* and *Rhinolophus rouxi*. These three species formed two-third of the total population.

The association of *Rhinopoma hardwickei* with *Hipposideros speoris* has been reported earlier (Brosset 1962). However, the association of this species with *Hipposideros bicolor* and *Rhinolophus rouxi* observed for the first time is worth mentioning.

ACKNOWLEDGEMENT

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VIRUS RESEARCH CENTRE, H. R. BHAT
INDIAN COUNCIL OF MEDICAL RESEARCH, M. A. SREENIVASAN
POONA,
October 5, 1971.

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[1] BROSSET, A. (1962): The Bats of Central and Western India, Part I. *J. Bombay nat. Hist. Soc.* **59** (1): 1-57.

2. NILGIRI TAHR (*HEMITRAGUS HYLOCRIUS*) 'SADDLE BACKS'

I wish to make the following comment on Dr. George Schaller's excellent report on the Nilgiri Tahr which appeared in the December 1970 issue of the *Journal* [Vol. **67** (3) : 365-389].

Dr. Schaller estimates the saddleback population in the Nilgiris at 9·1%, which to my reckoning is on the high side. In the census I conducted in the Nilgiris in 1963, no attempt was made to classify the population according to age and sex. However, the Nilgiri Wild Life Association being primarily interested in sport, we did make a mental note of the 'Saddle backs' (which alone are allowed to be shot on licence) seen. There were less than 10 out of the 292 tahr seen—if my memory serves me right—8.

In all my several trips to the tahr country spread over the last 17 years (the first 7 with the rifle, when incidentally, I failed to bag any) I came across less than a score of saddle backs.

On a trip to the Grass Hills last April, among the 140 tahr I saw, there was only one saddle back. It is the universal complaint of sportsmen that saddle backs are difficult to come by. Shikar books prove it.

My estimate is that not more than 3 or 4% of the tahr in the Nilgiris are saddle backs.

I have discussed Dr. Schaller's figure with knowledgeable and observant sportsmen and professional shikaries and their estimate is 2 to 3%. As regards the High Range tahr Mr. J. C. Gouldsbury writes: 'I was also surprised at George Schaller's figures of saddle backs on the Eravikulam and questioned him about it at the time, but I know that he did a very careful count and it is difficult to believe that he could have been far out.'

Dr. Schaller with whom I raised this point has replied: 'That your figures with respect to the number of saddle backs do not agree with one is not surprising. It is easy to find a big herd or two of females and young yet not a single saddle back. These males tend to congregate, often far away from the female-young herds. As I indicated in my article, in the Eravikulam, 30 out of 69 large males were in one corner of the reserve. Had I missed that corner in my census, my tally for saddle backs would have been much, much lower. Similarly, in the Bangitappal-Sispara area I found very few males—until I climbed to the highest hill in the southern part and there were several male herds, raising my tally considerably. So unless one censuses a whole region, samples can be misleading. The best time of the year in which to conduct a census would be during the rut when the males are with the females. I hope you will be able to do such a census and it would be most valuable to publish your results of censuses in the same area at different times of the year. This would give a good check on whether or not our figures are biased.'

I agree with Dr. Schaller's observations, but dispute his assumption that my low figure is due to certain areas having been left out of the reckoning. Some of us locals know the area quite intimately and my statement is based on observations made, over a period of time.

To get a tahr shot under licence passed as a saddle back exacting standards are employed. Having been used to such standards we tend to become cautious in the choice of our saddle backs. In defence of Dr. Schaller it must be said that not being used to these standards he has erred on the liberal side.

Several questions arise and for which answers are wanting.

When the percentage of young bucks is fairly high why should the saddle back population be so low? Whether the saddle mark vanishes and reappears depending upon the age of the tahr and season? Whether the saddle mark appears at a very late age? Whether some male tahr do not develop the saddle at all?

It has been observed in the Nilgiris that during certain years there is a much higher percentage of saddle backs (but never as high as even 5%) than during others. It is not always that a saddle back carries a longer pair of horns than a brown buck. Do these provide a key to some of the answers?

'CANOWIE',
COONOOR-1,
NILGIRIS,
July 2, 1971.

E. R. C. DAVIDAR

3. BIRTH OF AN INDIAN PANGOLIN (*MANIS CRASSICAUDATA*) IN CAPTIVITY

A pregnant female of the Indian Pangolin (*Manis crassicaudata*) with the Nandankanan Biological Park (Orissa) since 26.x.1971, gave birth to a male young on 17.xi.1971. The new-born young measured 30 cm from tip to tip including a 12·5 cm long tail and weighed 235 gm. The eyes were open at birth and the young was able to crawl over the mother's body soon after birth. The new-born young had soft scales and coarse grey hairs were present on the under-surface of almost all the scales throughout the body and projecting beyond the scales. After delivery the mother weighed 10·6 kg. The mother along with the young curled up keeping the young under the ventral part of her body and made a hissing sound as a sign of annoyance when disturbed. The young when handled could not curl up like the adults. It was rejected by the mother on the 4th day, and died the next day.

There is no mention of weight, size and condition of the eyes of the new-born young in the available literature. There are records of birth of this species in India in July (Prater 1971, BOOK OF INDIAN ANIMALS) and in November (Asdell 1964, PATTERNS OF MAMMALIAN REPRODUCTION).

VET. ASST. SURGEON, L. N. ACHARJYO
NANDANKANAN ZOO,
P.O. BARANG, (CUTTACK).

WILD LIFE CONSERVATION OFFICER, R. MISRA
ORISSA, CUTTACK-1,
January 5, 1972.

4. SOME OBSERVATIONS ON DISTRIBUTION OF ZOO BIRTHS AMONG COMMON WILD MAMMALS[1]

Acharjyo (1970) noted birth weight, size, gestation period, litter size, etc., of some common wild mammals maintained at the State Biological Park, Nandankanan (Orissa). In this paper monthwise distribution of zoo births among twelve species of wild mammals observed at the State Biological Park, Nandankanan (Orissa) during the past nine years and five months (from 29.xii.60 to 31.v.70) are reported.

OBSERVATIONS AND DISCUSSION

1. **Spotted Deer** (*Axis axis*)

A total number of 110 births (59 ♂♂, 51 ♀♀) have been recorded here as follows. January, 10; February, 28; March, 22; April, 12; May, 13; June, 1; July, 6; August, 3; September, 2; October, 4; November, 3; and December, 6. From this it appears that there is a definite concentration of births in the months of February and March.

According to Crandall (1964) fawns may be born at any season and the distribution of 225 births at New York Zoological Park was as follows: January, 8; February, 15; March, 30; April, 21; May, 30; June, 25; July, 27; August, 16; September, 18; October, 17; November, 17; and December, 1. Asdell (1964) states that in Ceylon young are born throughout the year but the majority at the beginning; at Woburn most fawns are born between Christmas and Easter and in London Zoo births were evenly distributed throughout the year. Fawns may be seen at any season (Prater 1965). Fawns of all ages and sizes can be found at all times (Walker *et al.* 1964).

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[1] Abstract submitted to Indian Science Congress, 58th Session held at Bangalore in January, 1971, in the Zoology Section.

2. **Indian Sambar** (*Cervus unicolor niger*)

The 35 births (14 ♂♂, 21 ♀♀) recorded here were distributed almost evenly throughout the year except May as follows : January, 1 ; February, 2 ; March, 1 ; April, 2 ; June, 5 ; July, 2 ; August, 5 ; September, 4 ; October, 5 ; November, 3 ; and December 5.

According to Crandall (loc. cit.) births in captivity may occur at any season and distribution of 41 births of New York Zoological Park were as follows : January, 2 ; March, 1 ; April, 4 ; May, 6 ; June, 5 ; July, 4 ; August, 2 ; September, 5 ; October, 7 ; and November, 5. Asdell (loc. cit.) states that in London Zoo births have been spread throughout the year with a peak at the end of May and at Woburn fawns were dropped at any time of the year. Young are born at the commencement of rains ; in late May or early June (Prater, loc. cit.).

3. **Barking Deer or Muntjac** (*Muntiacus muntjak*)

The birth of 51 fawns (25 ♂♂, 26 ♀♀) were spread almost evenly throughout the year as follows : January, 4 ; February, 5 ; March, 2 ; April, 5 ; May, 5 ; June, 4 ; July, 4 ; August, 4 ; September, 7 ; October, 3 ; November, 4 ; and December, 4.

Crandall (loc. cit.) citing Blanford (1888-91) states that the young are usually born in June or July though some may be produced throughout the year. In London Zoological Gardens 30 births of Indian Muntjac were distributed through every month of the year except January (Zuckerman 1953). Prater (loc. cit.) states that births occur at the beginning of rains. Young are born in July and August in north of India (Asdell, loc. cit.).

4. **Hog Deer** (*Axis porcinus*)

Four premature births recorded here were as follows : March, 1 ; May, 1 ; and October, 2.

According to Crandall (loc. cit.) the 32 births at New York Zoological Park were distributed throughout the year except in August and December. Births all the year have been recorded in London Zoo (Asdell, loc. cit.). Prater (loc. cit.) states that young are dropped in April, May and during the rains. Fawns of all ages and sizes can be seen at all times (Walker *et al.*, loc. cit.).

5. **Black Buck** (*Antilope cervicapra*)

Eleven births recorded in this Park were as follows : January, 2 ; February, 2 ; March, 1 ; May, 3 ; and September, 3.

According to Crandall (loc. cit.) 97 young born at New York Zoological Park were distributed throughout the twelve months of the year with minimum of one young in January and the maximum of 13 young in June. Asdell (loc. cit.) states that in London Zoo births were evenly distributed throughout the year.

6. **Nilgai** (*Boselaphus tragocamelus*)

Five births recorded in this Zoo were distributed as follows : January, 1 ; February, 2 ; and March, 2.

Crandall (loc. cit.) states that 8 births of New York Zoological Park were scattered from January to November. Sixty-one births at the Zoological Garden, London, occurred in every month, (Zuckerman, loc. cit.). The young are produced at all seasons (Prater, loc. cit.).

7. **Indian Wild Boar** (*Sus scrofa cristatus*)

Births of 6 litters in this Zoo were scattered from April to October as follows : April, 2 ; May, 3 ; and October, 1.

The majority of young are born shortly before and shortly after the rains in Central India (Prater, loc. cit.).

8. **Bonnet Macaque** (*Macaca radiata*)

Three births were recorded in the month of June, 1 ; July, 1 ; and August, 1.

Prater (loc. cit.) states that whether there is a marked breeding season is not known.

9. **African Lion** (*Panthera leo*)

Births of three litters were recorded as follows : February, 1 ; March, 1 ; and June, 1.

In the Gir forest of India, lion cubs are produced between January and February (Prater, loc. cit.). It has no fixed breeding season and is polyestrous (Asdell, loc. cit.). It is polygamous and breeds throughout the year (Walker *et al.*, loc. cit.).

10. **Tiger** (*Panthera tigris*)

Two litters were born here with one in July and the other in December.

One tigress at the New York Zoological Park produced eleven litters as follows : May, 8 ; June, 1 ; and November, 2 (Crandall, loc. cit.). Asdell (loc. cit.) states that in London Zoo, births have occurred at any time of the year but mostly from June to August. In India majority of young are born between February and May (Prater, loc. cit.).

11. **Leopard** (*Panthera pardus*)

Five litters born here were scattered as follows : April, 1 ; May, 1 ; June, 2 ; and December, 1.

Crandall (loc. cit.) citing Zuckerman (loc. cit.) reported that the 27 births at the London Zoological Garden during 1839 to 1937 occurred in every month except January. In India most births occur in April and in London Zoo births have been distributed throughout the year (Asdell, loc. cit.). Panther breeds all the year round (Prater, loc. cit.); Walker *et al.*, (loc. cit.).

12. **Common Mongoose** (*Herpestes edwardsi*)

Two litters were born, one in April and the other in July.

This has no regular season (Asdell, loc. cit.). It breeds all the year round (Prater, loc. cit.).

ACKNOWLEDGEMENTS

The authors are grateful to Sri D. N. Choudhury, I.F.S., Chief Conservator of Forests, Orissa, and to Sri S. Jee, I.F.S., Conservator of Forests, Development Circle, for the facilities provided.

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WILD LIFE CONSERVATION OFFICER, G. S. PADHI
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CUTTACK-1.
April 6, 1971.

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5. THE GREY PARTRIDGE (*FRANCOLINUS PONDICERIANUS*) IN THE BOMBAY KONKAN

In Vol. **68** (1) page 267 we had listed the recovery of a Grey Partridge at Kalyan, Thana Dist. The Grey Partridge does not occur in the Bombay Konkan, below the ghats and the bird in question was one of twenty-eight illegally captured by a trapper in an undisclosed locality and brought to Bombay for sale. The birds were confiscated from him by Mr. Humayun Abdulali, an Honorary Game Warden, and ringed and released by him at Kalyan.

Bombay Natural History Society, EDITORS
Bombay,
October 2, 1971.

6. THE GENUS *CUCULUS*: TWO AMENDMENTS TO THE 'HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN'

(*With a text-figure*)

The HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, volume 3 (hereafter referred to as the HANDBOOK) lists under the heading Himalayan Cuckoo only the nominate subspecies *Cuculus s. saturatus*, 'probably resident' along the Himalayas and in the hills of northeastern India. 'Museum diagnosis' is based on 16 specimens from Nepal and Sikkim, which have a wing length range of 172-192 mm, within the limits of nominate *saturatus* as set by Junge (1937)[1]. Figures of 208-226 mm quoted in the FAUNA OF BRITISH INDIA, volume 4 (Baker 1927) are rejected[2], but several specimens from the Indian subcontinent recently examined by the author in the collections of the British and Leiden Museums do not conform with Junge's definition and it is intended to show that treatment of the species in the HANDBOOK should be amended.

These collections include 58 post-juvenile and adult Himalayan Cuckoos collected along the Himalayas, from Hazara on the Pakistan-Afghanistan border east to Assam and Manipur, and two identifiably lowland specimens, an adult male taken on 18 May at Sholapur, Bombay State (17·43°N, 75·56°E) and an adult female on 31 May at Fatehgarh, either M.P. (24·47°N, 77·00°E) or U.P. (27·22°N, 79·38°E)[3]. Dated specimens occur only between 14 March and 20 October, with a conspicuous gap during the winter period which is hardly in accord with 'probably resident' status, though forest cuckoos are elusive outside the calling season (March-August according to the HANDBOOK) and problems of collecting during this period may account for lack of specimens.

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[1] Figures of 179-194 mm derived from skins in the BNHS collection by Humayun Abdulali (1971 *in litt.*) are also within Junge's range for the nominate subspecies.

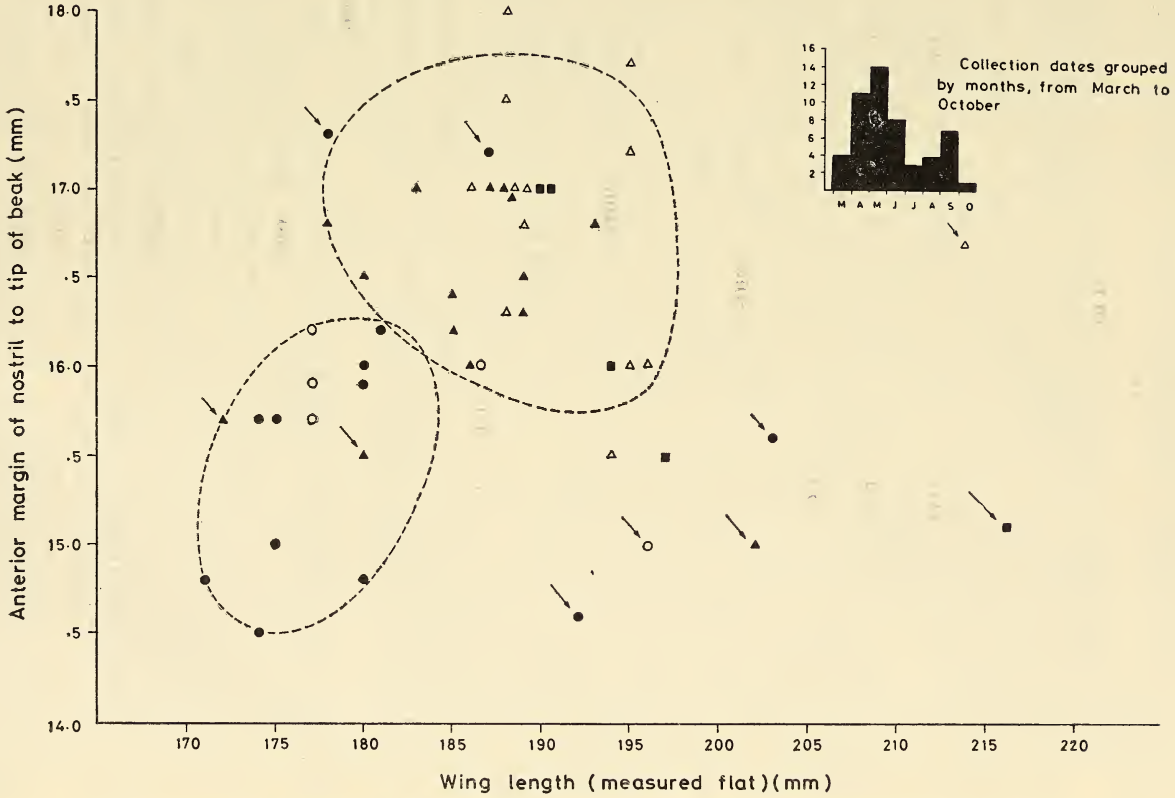
[2] Since the maximum authenticated wing length recorded for the Himalayan Cuckoo is only 217 mm (Dementiev & Gladkov 1951; Leiden Museum collection) it is possible that Baker confused his material with the Common Cuckoo *Cuculus canorus*.

[3] The original labels read 'Sulapur' and 'Futtighur'. Sholapur and Fatehgarh were the only possible modern alternatives that could be found.

Baker (1927) and Ripley (1961) have suggested that dispersal away from the hills occurs after the breeding season but whatever the annual cycle of subcontinent breeding populations, grouping of the collection dates by month reveals a suspiciously bimodal distribution. Most records cluster into the period late March-early June, with a lesser resurgence in August-September. Of the 10 specimens labelled ' June ' only 2 are known to have been collected in the second half of the month, and there are only 3 records for the whole of July. Of the 11 August-September birds, moreover, 7 are in adult plumage, which suggests that the second peak atleast may reflect passage migration rather than mere abundance at the end of a local breeding season. This interpretation is not inconsistent with recorded dates of arrival of spring migrants in western and central U.S.S.R., and arrival and departure periods in the known Southeast Asian and Australasian wintering range. Dementiev and Gladkov (1951) cite the following dates of first arrival in spring : 10-12 May in the central Urals, 29 May in the Altai, and early June on the lower Yenesi, near the arctic circle. Extreme dates among 132 specimens collected in the winter range, from the Andamans and Greater Sunda Islands east to New Guinea and Australia, are ' August ' (Borneo) and 6 June (Ternate, Moluccas), although most records fall within the period late September-late March. It is also of interest to note that all except one of the specimens collected in the subcontinent during August-September are from Sikkim and Assam, that part of the region on the most direct route from the central Palaearctic to Southeast Asia and beyond.

Measurements were made of the flattened wings of all post-juveniles and adults, except those moulting the longest remex (primary VIII descending) or retaining small, juvenile remiges. This gave a wing length range of 180-216 mm for subcontinent males and 174-203 mm for females, reduced to 171 mm by the inclusion of 2 individuals from the BNHS collection, misidentified as *Cuculus poliocephalus* (see below). Thirteen specimens are larger than the upper limit of 192 mm quoted by the HANDBOOK for nominate *saturatus*, including 8 males wing 195-214 mm, 2 females wing 196 mm and 203 mm, and 3 unsexed birds wing 193, 194 and 216 mm. Four of these are beyond the absolute upper limit of 197 mm set by Junge for the nominate subspecies and well within the range he quoted for the northern breeding *horsfieldi*, which is not included in the HANDBOOK. It should be pointed out, however, that the two subspecies have a continuous north-south distribution at least in the far-eastern part of the breeding range and merge over a wider size range than the 5 mm that Junge proposed. He cited 192 mm as an absolute lower limit for the wing of *horsfieldi*, breeding across the U.S.S.R., in Japan and northern China south (Cheng 1964) to about the latitude of Kiangsu. But the British Museum possesses a male from the Shantung

Two morphological variables in 50 specimens of Cuculus saturatus from the Indian subcontinent



KEY: △▲ males ; ○● females ; □■ unsexed specimens. Solid figures represent specimens collected from Nepal eastwards, open figures specimens from Naini Tal and Gilgit westwards.

peninsula with a wing of only 185 mm, a female from northern Manchuria wing 186 mm and 3 females from the Yenesi, central Siberia, wings 182, 190 and 190 mm. It is noteworthy also that Kobayashi (1967) quotes a lower limit of 184 mm for Japan, while Dementiev and Gladkov go to 175 mm for the U.S.S.R., although they do not give the source of their information.

To investigate the homogeneity of the Indian subcontinent sample, wing lengths were thus plotted against a second parameter, the distance from the anterior margin of the nostril to the tip of the beak. This measurement was selected because it is relatively easy to make in a dried skin and also because beak size varies from population to population, apparently independent of total body size as indicated by wing length. The scatter of points resolved itself into 2 major clusters (see diagram). Males centred on a beak length of about 16·0-17·5 mm (the western Himalayan sample skewed towards the upper end of the range, the eastern towards the lower) and a wing length of about 180-195 mm (no western birds under 185 mm). Females centred on a beak length of about 14·5-16·0 mm and a wing length of about 173-180 mm (the two sub-groups in this second cluster are not geographically separable).

Having proposed the possibility of migrants occurring until early June and from August onwards it was impossible to select as a standard of reference an adequate sample of guaranteed local breeding birds since so few specimens were available for late June or July. But since the centre groupings of both main clusters included birds collected in April, May and June there is reasonable likelihood that at least some local breeders were incorporated (the HANDBOOK gives May-June as the principal breeding season). The size limits of local breeders obviously cannot be defined on present data but rough limits of the centre groupings of each cluster have been sketched in by eye, thereby isolating the more extreme deviants (marked by arrows in the diagram). A few of these can be eliminated immediately as probable errors of labelling. ' Males ', wing 172 mm, beak 15·7 mm (Sikkim, 27 May) and wing 180 mm, beak 15·5 mm. (Nepal, no date) are so close to the centre groupings for females that they probably belong there. Conversely, ' females ', wing 178 mm, beak 17·3 mm (Assam, 29 August) and wing 187 mm, beak 17·2 mm (Fatehgarh, 31 May) are both far from their appropriate centre grouping but close to that of males. It will be noted, however, that by its locality the Fatehgarh bird must be a migrant, or at least a dispersant.

Six other plots are distinctive : including males, wing 203 mm, beak 15·0 mm (Shillong, Assam, 15 August), well above the wing range but below the beak range of the centre grouping, and wing 214 mm, beak 16·7 mm (Sholapur, Bombay, 18 May), and a third, unsexed, bird wing 216 mm, beak 15·1 mm (Assam, no date) which is also far above the wing range of either centre grouping. By its size it can only be a male. Three individuals sexed as females, wings 192, 196 and 203 mm, beaks 14·6, 15·0 and 15·6 mm, respectively, from Assam (4 September), Muree hills, West Pakistan (25 May), Shillong, Assam (' May ') are well out of the female centre grouping on wing length and even if wrongly sexed are too short in the beak to fit comfortably into the male centre grouping. Collection dates for 5 of the 6 fall within putative migration periods and the only undated specimen happens also to be the most extreme deviant on size. These individuals are, thus, sufficiently distinct to establish with fair certainty that migrants from elsewhere in the species breeding range do occur in the subcontinent. Their wing lengths place them well with the range of the northern breeding *horsfieldi*, which should be added to the Indian list, but no guesses can be made as to whether all migrants passing through India belong to this subspecies.

The second proposed amendment concerns the Little Cuckoo *Cuculus poliocephalus*. The HANDBOOK follows Baker (1927) in quoting an upper limit of 171 mm for wing length but states that this measurement is exceptional, 9 mm above the ' normal ' maximum. The only beak measurement given is length from skull but among a large number of specimens of supposed *C. p. poliocephalus* in the British and Leiden Museum collections, 2 categories could be recognised on beak morphology. The vast majority of individuals had slender beaks, length from the anterior margin of the nostril to the tip as follows : 10 migrants from East Africa and the Seychelles 13·0-14·6 mm ; 5 presumed migrants from Ceylon 13·2-14·5 mm ; 38 birds from the Indian subcontinent 12·0[1]-15·1 mm ; 2 from Burma 14·0 and 14·9 mm ; 23 from China 13·1-15·1 mm, and 9 from Japan 13·7-14·9 mm. Wing lengths of this group fell within the range 143 mm-161 mm, with 3 adults from Japan, Kiangsu and Yunnan wing 164 mm and one from Mt. Victoria, central Burma wing 167 mm. The sample from the Indian subcontinent had a wing range of 143-160 mm.

Two individuals in the British Museum from Sikkim and Darjeeling had distinctly deeper and heavier bills, length 15·0 and 18·0 mm, and wings of 174 and 175 mm. A similar bird, beak 16·5 mm, wing 168 mm, was also found among *C. p. lepidus* in the Bartels collection from western Java (Leiden Museum). No difference could be found between the shape of the beak in these birds and that of a large series of nominate *C. saturatus*, which also contained a number of specimens identical to the individuals in question in every other respect. In fact, when comparing large series no consistent plumage character could be found that reliably separated *saturatus* and *poliocephalus*. It was, therefore, concluded that these 3 birds had been wrongly identified and were really *saturatus*. Interestingly, the Javan specimen had the name '*optatus*' (a synonym of *saturatus saturatus*), apparently in Junge's handwriting, pencilled in on the collector's label.

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[1] This measurement is from an unsexed adult labelled Sikkim. All juveniles have been excluded from the series investigated since they have much smaller beaks than adults, the beak in some individuals not reaching full size until after the post-juvenile moult. The same is true of *Cuculus saturatus* and the small beak is presumably an adaptation to being fed as pulli and fledglings on small insects by relatively tiny foster-parents.

Recently, the author has also been able to go through *C. poliocephalus* in the BNHS collection at Hornbill House. Two specimens (cat. nos. 10627, 10636) stood out from the rest, with wing lengths of 171 and 172 mm in a series which otherwise did not exceed 160 mm (my measurements of flattened wings). They had rather short beaks, length from the anterior margin of the nostril 14·8 and 15·7 mm, but these measurements are within the range of undoubted nominate *saturatus* and in both birds the beak was of the heavy, *saturatus* type. Abdulali (1971 *in litt.*) has subsequently pointed out that they have tails of only 130 mm, short for subcontinent *saturatus* available to him, but the measurement is still within the accepted range for the species. Kobayashi (1967), in fact, quotes a range down to 124 mm for Japanese *saturatus* of wing not less than 184 mm.

These birds are very similar to the 3 London and Leiden specimens and have been re-identified as nominate *saturatus*. They both still carry E. C. S. Baker's original (field ?) labels, reading *C. poliocephalus*, Sikkim 27 May 1904, and there are grounds for supposing that these are the specimens used by him to define the upper limit of wing length of his *C. poliocephalus* as 171 mm in the FAUNA, volume 4 (the difference of 1 mm between this figure and that quoted above can be dismissed as a personal variation in measuring technique). It is suggested that this figure should now be deleted from the HANDBOOK's treatment of the Little Cuckoo and that the upper limit of wing length for *C. poliocephalus* collected in India be reduced to 162 mm.

In reviewing records of putative migrant *C. p. poliocephalus* in Southeast Asia it has become evident that some (and possibly all) are due to misidentification of small nominate *saturatus*, presumably based on Baker's figures, which have been widely copied. In fact, there is growing doubt as to whether *C. p. poliocephalus* occurs at all in Southeast Asia away from the higher hills of northern and central Burma. If it is established that its migration pathway is entirely southwestwards, to East Africa, then the usual supposition that *C.* '*p*'. *lepidus*, resident in Malaysia and Indonesia, is a subspecies of the Little Cuckoo is called to question (Becking in prep.; Wells in prep.).

I would like to thank the staff of the Bird Room, British Museum, Dr. G. F. Mees of the Leiden Museum and Mr. S. A. Hussain of

the Bombay Natural History Society for facilities to study the Society's collections.

ZOOLOGY DIVISION,
SCHOOL OF BIOLOGICAL SCIENCES,
UNIVERSITY OF MALAYA,
KUALA LUMPUR,
MALAYSIA,
October 16, 1971.

D. R. WELLS

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7. OCCURRENCE OF THE EGYPTIAN NIGHTJAR *CAPRIMULGUS AEGYPTIUS AEGYPTIUS* LICHTENSTEIN IN BALUCHISTAN

The Egyptian Nightjar (*Caprimulgus aegyptius aegyptius* Lichtenstein) is not included in Stuart Baker's FAUNA or in Sálim Ali and Ripley's INDIAN HANDBOOK. While cataloguing the nightjars it was noticed that though C. B. Ticehurst (1927) in *The Birds of British Baluchistan* (*JBNHS* **31**: 880) referred to *C. aegyptius* not occurring nearer than Bampur in Persian Baluchistan, Peter's Checklist (1940, **4**: 205) refers to its occurrence in ' Baluchistan '. A little later (1942) Major General A. P. F. Christison in *Some Additional Notes on the Distribution of the Avifauna of Northern Baluchistan* (*JBNHS* **43**: 483) refers to a specimen obtained at Rabat on the Afghanistan-Iran-Baluchistan frontier on 12 April and seeing another. He adds ' Natives know it well and say it comes to nest there, but I could find no one who had seen its eggs '.

His specimen, a male, had a 208 mm wing, which is larger than *C. europaeus unwini* (172-192 mm) and *mahrattensis* (157-173 mm) which would be the only species with which it could be confused. It would also appear that the collection was checked upon by C. B. Ticehurst, and there is no reason to question this record. Its omission in

INDIAN HANDBOOK is either an oversight or due to the fact that though Rabat Thana is clearly shown on the Baluchistan side of the Afghanistan-Iran-Baluchistan border (pl. 49 of map volume of Imperial Gazetteer of India, 1931) it is omitted in the index which includes three other places of the same name, two in Afghanistan and one north of Chitral, N.W.F.P.

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Bombay Natural History Society, S. A. HUSSAIN
Shahid Bhagat Singh Road,
Bombay-1,
April 12, 1971.

8. NORTHERN RANGE OF THE EASTERN PALM SWIFT [*CYPSIURUS PARVUS INFUMATUS* (SCLATER)]

Both the FAUNA and IND. HANDBOOK (**4** : 57) state that the Eastern Palm Swift [*Cypsiurus parvus infumatus* (Sclater)], originally described from Borneo, is found only south of the Brahmaputra River. The Bombay Natural History Society collection contains one unmistakable specimen (No. 11611) collected by H V. O'Donel in 'Bhutan Duars' on 7 July, 1915, and marked as *infumatus* in the original label. It would appear therefore that *infumatus* is also found north of the Brahmaputra. Somehow, though O'Donel was one of the four contributors to 'A Tentative List of the Vertebrates of the Jalpaiguri District, Bengal' (*JBNHS* **26** : 998), reference is made in this paper only to *Tachornis batasiensis.*

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Bombay Natural History Society, S. A. HUSSAIN
Bombay-1,
December 20, 1971.

9. MOVEMENT OF BLYTH'S REED WARBLER (*ACROCEPHALUS DUMETORUM* BLYTH) THROUGH POINT CALIMERE

During this season (1970-71) we ringed 2359 Blyth's Reed Warblers at Point Calimere, as against only 198 during the last (1969-70) season. Month-wise collections for the two years are as follows :

		1969-70	1970-71
October	..	4	25
November	..	40	1062
December	..	16	825
January	..	64	274
February	..	30	103
March	..	44	70
Total	..	198	2359

From these figures it is evident that catches in 1970-71 were over ten times more than those of 1969-70, eventhough no special effort was made to catch them. The following table gives peak catches on some days during Nov. '70, and the weather conditions on those days.

Date	No. of birds netted	Weather conditions
Nov. 9	..	Heavy rain
,, 10	138	Overcast sky
,, 11	65	Drizzle
,, 12	29	Drizzle
,, 13	43	Normal
,, 15	128	Heavy rain, overcast sky
,, 24	..	Heavy rain, wind
,, 25	251	Drizzling whole day

In view of these unusual catches during inclement weather, it is perhaps possible that these birds might have been wind-driven towards Point Calimere by the prevailing NE. winds and inclement weather conditions while travelling further south. To the Ceylon-bound Passerine a more practical route than the Calimere-Jaffna crossing, would seem to be through Rameswaram Island further south. However, further observations are needed.

BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY-1. BR.,
September 15, 1971.

K. S. R. KRISHNA RAJU
P. B. SHEKAR
P. J. SELVIN

10. THE ECOLOGY OF THE BAYA IN RAJAMPET, CUDDAPAH DT., A.P.

(*With a map*)

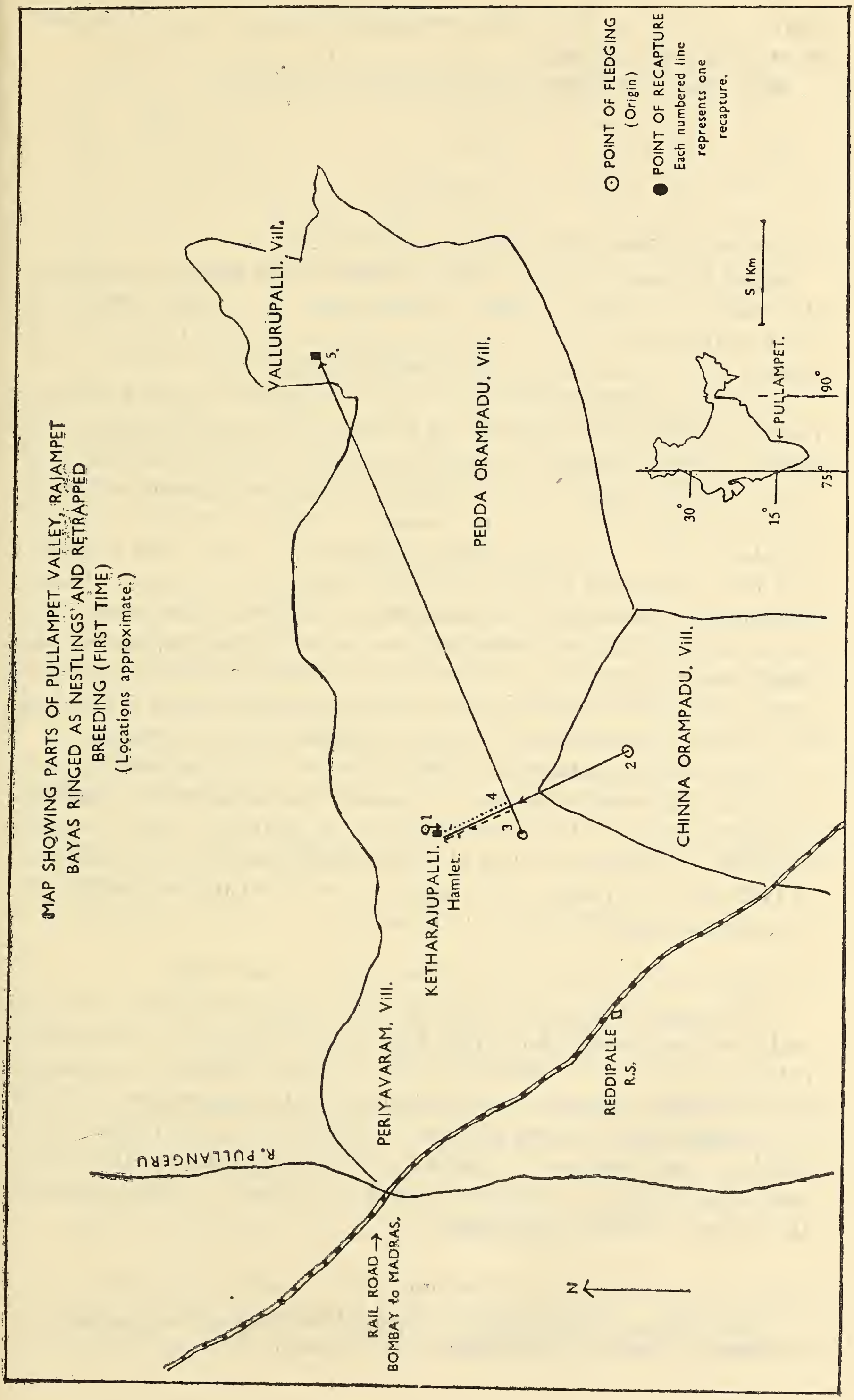
INTRODUCTION

While working on the ecology of the Baya (*Ploceus philippinus*) around Reddipalli (*c.* 14°N., 79°E.), Rajampet Taluk, Cuddapah Dt., I had ringed 460 nestlings and 1055 older birds of different ages of the Baya in five villages in the area, between 1968 April and 1971 February. As most of the nestlings were ringed in 1970 the age at first breeding of the Baya (in this area) could not be determined. The present study was aimed mainly at filling this gap in knowledge, but three other aspects namely the pattern of dispersal of the first year Baya, the primary sex-ratio of the Baya, and the population index on breeding Bayas of a restricted area near Reddipalli were also investigated to a limited extent.

AREA OF STUDY

The area of work lies at points 1-5 kilometres east and northeast of Reddipalli Railway Station of Southern Railway. It is situated in the southern part of Cuddapah district, in the Pullampet valley which is a region of stratified rocks covered by river alluviums, blown sand, and gravel. Due to scanty annual rainfall the uncultivated parts can be called dry scrub jungle with shrubs like *Plectronia parviflora*, *Azima tetracantha*, *Ehretia microphylla*, *Fluggea leucopyrus*, *Gymnosporia montana*, *Acacia concinna*, and *A. leucophloea*. Dates, *Phoenix sylvestris* and *P. farinifera* grow wild in many places.

Paddy is the main crop of the area, but millets, groundnut, turmeric, castor, mustard, onion, mango, limes, sugarcane and betelvine are also grown. Paddy, millets and seeds of several species of Panicacea weeds provide a continuous supply of food to the Bayas and ringing showed these weaver birds to be resident in the area of study. Plantations of sugarcane, mango and betelvine and scrub jungles are used by the Bayas for roosting. Bayas nest in this area from mid-April to mid November, in colonies centered around wells, canals, in scrub jungle and gorges of hills. Nests are built on trees like *Phoenix* sp., *Syzigium jambolanum*, *Ficus religiosa*, *F. glomerata*, *Azadirachta indica* and *Pongamia glabra* and on thickets of *Lantana* sp., *Zizyphus jujuba* and *Acacia* sp. Leaves of *Phoenix* sp. were the chief source of material for nests but leaves of paddy, millets, coconut and the grass *Cymbopogon coloratus* were also used. Thus suitable nest-sites, nesting material and roosts are available throughout the year. However, the cultivation of paddy, the chief



MAP SHOWING PARTS OF PULLAMPET VALLEY, RAJAMPET BAYAS RINGED AS NESTLINGS AND RETRAPPED BREEDING (FIRST TIME)
(Locations approximate)

VALLURUPALLI. Vill.
PEDDA ORAMPADU. Vill.
CHINNA ORAMPADU. Vill.
KETHARAJUPALLI. Hamlet.
PERIYAVARAM. Vill.
REDDIPALLE R.S.
R. PULLANGERU
RAIL ROAD → BOMBAY to MADRAS.
N
1
2
3
4
5
⊙ POINT OF FLEDGING (Origin)
● POINT OF RECAPTURE Each numbered line represents one recapture.
5 1 Km
←PULLAMPET.
90°
75°
30°
15°

source of food of the Bayas here, varies in intensity as the area is irrigated by two large rain-fed tanks.

Birds were mist-netted around big breeding colonies.

RESULTS

1. *Age at first breeding of the Baya in Rajampet :*

Based on examination of birds dissected in 1968 and external characters such as plumage and bill colour in birds ringed from 1968-71 it was hypothesized that the female Baya breeds for the first time when it is about 1 year old and the male Baya when 1-2 years old.

In three trials by netting from 19 to 27 August at breeding colonies forty-seven Bayas were captured out of which seven carried rings put on earlier. Among the seven recaptured birds five had left nests after May 1970. The first was a male in complete breeding plumage and with black bill (on recapture) but it was not possible to preserve this bird as it was mistaken at the time for an adult and released. In the other four first year birds recaptured three were females which had left nests in August 1970 and were in breeding condition when recaptured. The fourth bird which had left nest in September 1970 was in non-nuptial plumage but had a lead-coloured bill. Dr. R. M. Naik who examined a section of the testis of this latter bird was of the opinion that this bird was capable of breeding in about six weeks, as spermatocytes were observed in the section.

As the breeding season of the Baya in the study area ends only in mid-November this male could have succeeded in breeding before reaching 15 months of age, but this depended also on its obtaining a female partner. Cases of male Bayas breeding in non-nuptial plumage were observed in 1970 but very rarely[1]. The specimens collected are useful references in judging the age of the Baya by appearance.

2. *Pattern of dispersal of the first year Baya :* (*See* Map)

Of the four retrappings of first year Bayas referred to earlier, two (one male and one female) birds had been raised respectively in the same colonies in the same months and were retrapped together at a common breeding colony situated *c.* 750 metres north of the ringing sites. A third was recaptured at a colony situated *c.* 1·8 kilometre north of the nest in which it was raised, and a fourth *c.* 1·48 km. northeast of the colony where it was raised. A fifth was netted at a colony *c.* 5 metres west of the colony in which it was raised.

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[1] These apparently, were not just young males practicing nest-building, but were not dissected to confirm actual breeding.

3. *Primary sex ratio of the Baya :*

Repeated counting of breeding adults in 1970 in an area of *c*. 282 ha. including *c*. 72 ha. of rice-fields showed a sex ratio of 1·4 male : 1 female Baya. Three cases of death of breeding females in or near the nests were observed in that season, but none of males. To see if the sex ratio was different in the nestlings 29 examples were dissected in the present study. In a group of 15 nestlings of approximately 1-5 days age, there were 7 males and 8 females and in an older group of *c*. 5-10-day-old nestlings males and females were in equal numbers, giving an overall sex-ratio of 1 male : 1·007 female in the nestling stage.

4. *A population index of breeding males :*

In an area (*c*. 282 ha.) where 68 male Bayas and 50 completed nests were counted on 28 August 1970, 54 males and 47 completed nests were counted in the present study. Cultivation of Paddy and millets was very much restricted this year due to failure of the monsoon in this area.

ACKNOWLEDGEMENTS

I am grateful to the Sálim Ali-Loke Wan Tho Ornithological Research Fund which supported this work, and to Shri V. K. Chari, Curator, Prince of Wales Museum, and to Shri J. C. Daniel, Curator, Bombay Natural History Society, for their help in organising this field work. I am grateful to Dr. R. M. Naik of the Faculty of Science, M.S. University of Baroda, for his advice, and to Miss Saramma Isaac, Research Assistant, Bombay Natural History Society, for helping in microtomy.

BOMBAY NATURAL HISTORY SOCIETY, D. N. MATHEW
BOMBAY-1, BR,
Septemper 13, 1971.

11. SOME NOTES ON THE SEA SNAKE *LATICAUDA COLUBRINA* (SCHNEIDER)

In March 1969 I spent a week (13th to 19th) on South Sentinel Island, one of the uninhabited islands of the southern end of the Andaman group, as a member of an Ornithological collection party of the Society. The following observations made then regarding the sea snake *Laticauda colubrina* (Schneider) may be worth recording.

The shore extends over 40 metres of the sand and our tents were pitched on the island edge of the mangrove jungle. After sunset I obtained a specimen of this snake near our tents, far from the water, and on the following evening we got another. During the course of our stay, I must have seen a dozen individuals on the sand. All were seen after sunset by torchlight and left the impression that they were headed for the jungle. Upon closer examination in Bombay, my specimens were found to be a male (812 mm) and a female (990 mm). The female had 7 eggs which showed no traces of development and measured 55-71 mm in length and 24-25 mm in breadth.

Smith's FAUNA, 1943, page 440, states that all species of the sub-family Hydrophiinae (family Hydrophiidae, sea-snakes) produce their young alive but makes no reference to the breeding arrangements of the other sub-family Laticaudinae. In a note in the *Bulletin of the Raffles Museum* 1931, **5** : 54, S. Smedley refers to between 1 and 6 eggs being laid by individuals in a tank containing sea water. He goes on to discuss the probability of these eggs being laid prematurely in consequence of captivity but quotes lighthouse-keepers as stating that they had seen females coiled around eggs laid in crevices in rocks. Allowing for Malcolm Smith's statement that he had examined a specimen containing embryos enclosed in a semi-transparent covering, he concludes that oviparity and ovoviviparity may occur in the same species.

I am unable to add any definite information in this respect but it would appear that the habits of this species are unusual for a sea-snake for, apart from their moving inland, one was found a couple of feet off the ground on the branch of a tree.

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BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY-1,
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R. J. PIMENTO

12. CANNIBALISM AND FEEDING IN TWO SNAKES, *TRIMERESURUS ALBOLABRIS* AND *AHAETULLA NASUTUS*

On 8 March 1965 I discovered that a young male Pit Viper (*Trimeresurus albolabris*) in my possession had killed and begun to swallow its Green Whip Snake (*Ahaetulla nasutus*) cagemate. As the former was a mere sixteen inches long and the latter thirty-six inches in length, this was at best a Pyrrhic victory. The pit viper succeeded in swallowing the first thirteen inches of the whip snake, before regurgitating its meal.

Once a skink (*Mabuya novemcarinata*) was dropped as food into a cage containing a *Ahaetulla nasutus* and a Bronzeback (*Dendrelapsis ahaetulla ahaetulla*). It was in due time struck by the Whipsnake and grasped by the right arm. The lizard broke free, when the snake turned and struck the Bronzeback, grasping it about an inch back of the head.

A struggle followed, at the end of which the bronze snake also broke free. On other occasions I have seen *Ahaetulla nasutus* strike and eat *Calotes versicolor* and *Platyurus platyurus*, both common lizards, and adult sparrows (*Passer montanus*).

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13. OCCURRENCE OF CEYLON KALOULA : (*KALOULA PULCHRA TAPROBANICA* PARKER) (FAMILY : MICROHYLIDAE) AT TAMBARAM, TAMIL NADU

In September, 1970, I collected a specimen of *Kaloula pulchra taprobanica* Parker in my house compound. It is interesting to note that the specimen was collected from a hollow in the branch of a Mango tree, about five feet above the ground level.

When alive the colour pattern differs from the description given by J. C. Daniel [*JBNHS* **60** (3) : 699] by the presence of the midbody being dark olive green. The tips of the warts on the dorsal side are white. Red patches are present on the legs and the chin. Lips red.

When put in loose wet sand it burrowed exactly like *Uperodon systoma* by dislodging the soil by the sideways movements of the hind legs, but it did not subside completely into the soil. The head was always kept above the ground level. When put in water it felt uncomfortable and tried to come out of the water. Poorly developed webs in the legs and its uneasiness in water suggests that it is comparatively a poor swimmer.

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SIMON G. RAJASINGH

14. THE DEEP SEA SPINED DOG FISH *CENTROPHORUS ARMATUS* (GILCHRIST) (SELACHII : SUALIDAE) FROM THE EAST COAST OF INDIA, WITH A NOTE ON ITS TAXONOMY

(*With a map and a text-figure*)

The spined dog fish *Centrophorus armatus* (Gilchrist) was first reported by Gilchrist (1922) from the east coast of Africa and later from Natal coast and Mozambique by others. Silas *et al.* (1969) recorded it from the west coast of India. The present report of it extends its distribution to east coast of India.

Gilchrist (1922) created the genus *Atractophorus* to accommodate the dog fish *armatus* Gilchrist based on an arrow head at the tip of its second dorsal spine. All other important generic characters such as dissimilar teeth in both jaws, and elongated inner margin of pectoral fin are common to *Centrophorus* Müller & Henle 1833 and *Atractophorus* Gilchrist, 1922. The specimens of *armatus* Gilchrist from Gulf of Mannar have a slight enlargement laterally at the tip of second dorsal fin which can be observed only when examined carefully. This character is not considered by us to be significant for generic separation. Many spined dog fishes like *Squalus acanthias* Linnaeus has such lateral enlargement in second dorsal spine during embryonic development (Ford 1921) which disappears later. Therefore, the species *armatus* should be placed in *Centrophorus* Müller & Henle, 1833, an earlier available name, as the important generic diagnostic characters of both the genera are the same. Barnard (1925) also found no reason for creating the genus *Atractophorus* for accommodating the species *armatus*, though he used the name *Atractophorus armatus*. Bigelow & Schroeder (1948) and Stead (1968) include the dog fishes with above characters in *Centrophorus* Müller & Henle, though Smith (1961) & Silas *et al.* (1969) recognise *Atractophorus* and place *armatus* in it.

From the Laccadive sea of Indian coast another spined dog fish *Scymnodon rossi* was described by Alcock (1898). Though many species of spined dog fishes are known to occur from Indian Ocean along the coast of Australia and Africa only two species are so far reported from the Indian coast, namely *Centrophorus armatus* (Gilchrist) and *Scymnodon rossi* (Alcock).

KEY TO THE INDIAN SPECIES OF SPINED DOG FISHES

1. Teeth noticeably dissimilar in both jaws; inner corner of pectoral broadly rounded; blades of dermal denticles with three to several ridges; marginal teeth on posterior and anterior parts of trunk. —*Scymnodon rossi* (Alcock)

2. Teeth noticeably dissimilar in both jaws; inner corner of pectoral produced: dermal denticles regular without blades; no marginal teeth on trunk. —*Centrophorus armatus* (Gilchrist)

Centrophorus armatus (Gilchrist)

(Fig. 1 A)

Atractophorus armatus Gilchrist. *An. rept.* **2**, *Fish. mar. Biol. Surv. Uni. S. Afr. Spec. rep.* **3**, 1922: 41-79; Barnard, *Ann. S. Afr. Mus.*, 1925, **21**, pt. 1: 51-52; Fowler, *Proc. Acad. nat. Sci., Philad.*, **87**, 1935: 361-408; *Bull. U.S. natn. Mus.*, no. **100** (13), 1940: 1-879; Silas *et al. Curr. Sci.* **38**(5), 1969: 105-106; Smith *Sea Fish S. Afr.* Capetn., 1961: 57.

TABLE

CHEMICAL COMPOSITION OF THE MUSCLE OF SOME COMMON FISHES AND DEEP SEA SHARK *C. armatus*

Species	Moisture	Protein %	Ash %	Phosphorus mg./100 gr.	Iron mg./100 gr.	Calcium mg./100 gr.
Common species*						
Carcharias limbatus ..	72·0	26·10	1·43	13·30	3·86	107·0
Sphyrna blochii ..	75·14	23·9	1·10	15·11	4·48	118·00
Dasyatis uaranak ..	77·5	20·04	1·15	18·92	6·15	152·00
Rhinoptera sewelli ..	75·25	20·9	1·24	270·5	5·30	178·60
Stromateus argenteus ..	71·00	16·69	1·48	21·24	3·76	250·00
Wak sina ..	77·41	17·25	1·38	21·46	4·73	97·54
Rastrelliger kanagurta ..	74·70	19·55	1·65	48·14	8·49	778·20
Hilsa toli ..	78·33	17·98	1·80	23·01	2·84	567·50
Lactarius lactarius ..	73·33	19·39	1·42	318·70	3·35	235·7
Harpodon nehereus ..	89·30	9·05	·74	18·6	1·29	334·2
Scomberomorus commerson ..	78·9	17·9	1·26	17·26	4·02	345·0
Muraenesox talabon ..	80·0	16·92	·91	26·52	4·24	280·0
Sardinella fimbriata ..	77·36	18·57	1·60	52·66	6·68	1136·00
Tachysurus dussumieri ..	78·10	12·72	·88	24·32	3·81	307·00
Polynemus indicus ..	77·38	15·50	1·29	14·77	4·50	125·30
Thunnus macropterus ..	71·94	23·84	1·80	358·00	6·78	435·70
*Centrophorus armatus*** ..	75·3-77·6	21·73-21·82	1·20-0·96	170·0-190·0	2·18-6·61	not known

* After *Wealth of India* **4** : 99 (1962). **After Silas (1969).

Description : Measurements in per cent of the total length. (After Bigelow & Schroeder 1948, modified). Female, 935 mm, 2 specimens, off Mandapam (Gulf of Mannar) CMFRI, F. 199/633a and b.

Trunk at pectoral origin : breadth 14·0-14·8, height 9·5-11·7. Snout length in front of : outer nostril 4·8, mouth 10·1-10·3. Eye : horizontal

Fig. 1

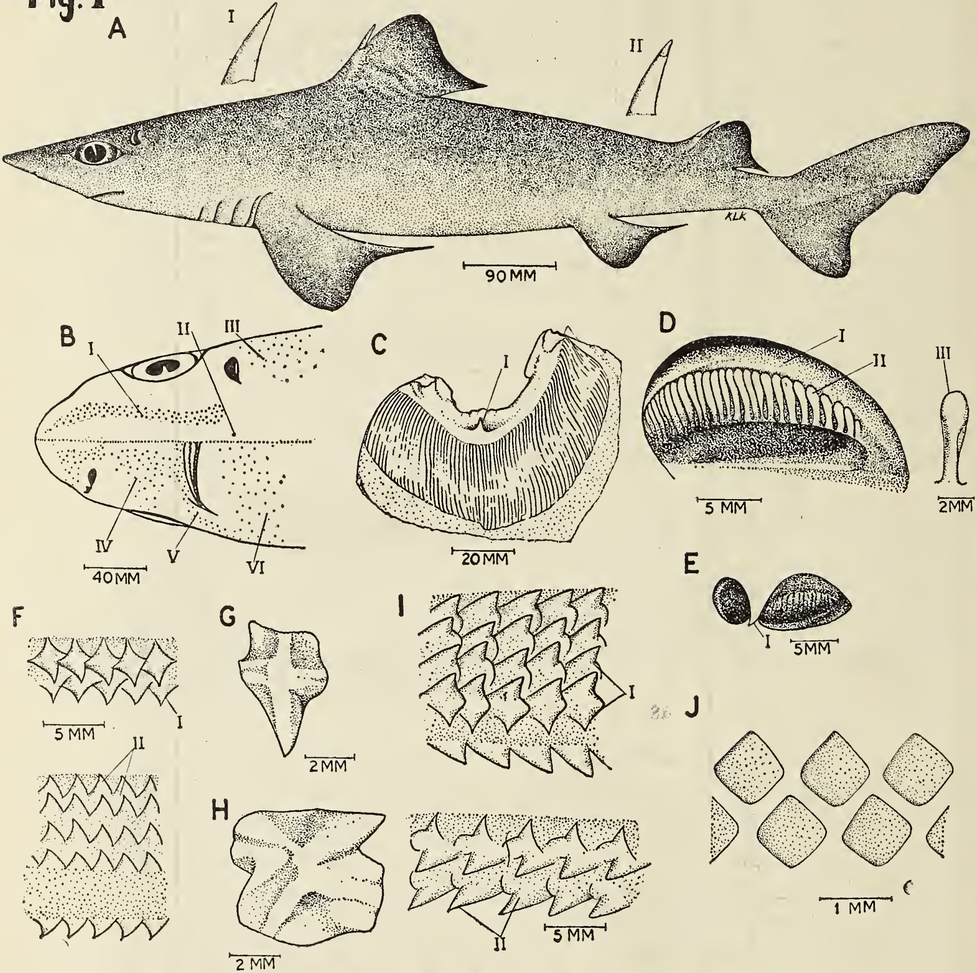


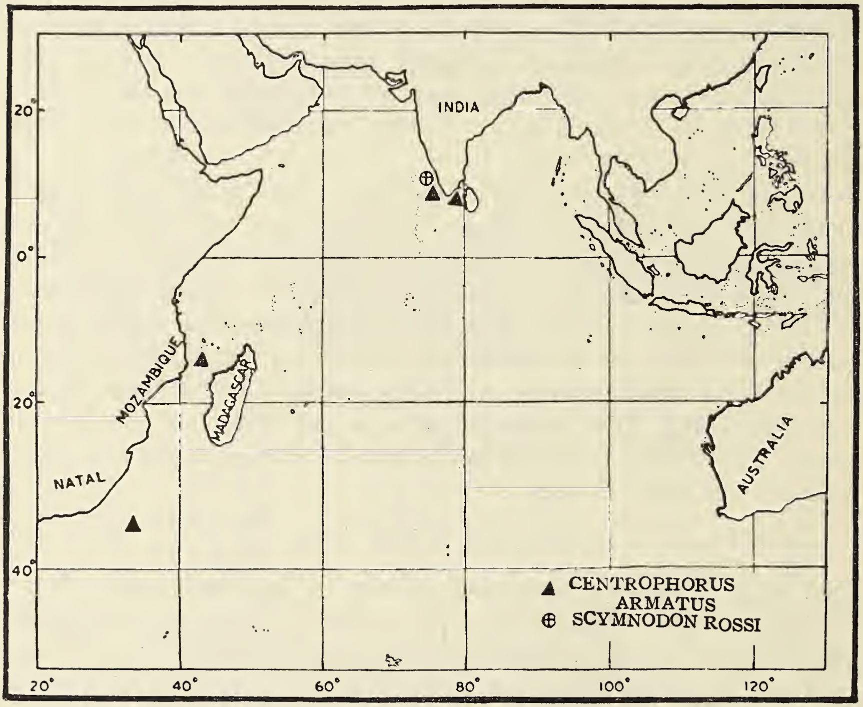
FIG. 1. A. *Centrophorus armatus* (Gilchrist) : Total length 935 mm. I. First dorsal spine (enlarged), II. Second dorsal spine (enlarged) ; B. Dorsal and ventral views of head. I. Supra-ophthalmic ampullae, II. Endolymphatic duct, III. Infra-spiracular ampullae, IV. Infra-ophthalmic ampullae, V. Mandibular ampullae, VI. Hyomandibular ampullae ; C. Fifth gill arch. I. Gill raker ; D. Median septum of the spiracle. I. Wall of the Septum, II. Spiracular filament, III. Spiracular filament (enlarged) ; E. Nostril. I. Nasal Flap ; F. Upper jaw teeth. I. Outer series (functional) ; II. Inner series (non-functional) ; G. Upper jaw tooth ; H. Lower jaw tooth ; I. Lower jaw teeth, I. Inner series (non-functional), II. Outer series (functional) ; J. Dermal denticles.

diameter 5·4. Mouth: breadth 8·6-9·9. Nostrils: distance between inner ends 1·8. Labial furrow from angle of mouth: upper 2·3-2·4, lower 3·8-4·0. Gill openings: first 2·6-3·2, second 3·4-3·7, third 4·2-4·3, fourth 5·0-5·8, fifth 6·7-7·6. First dorsal fin: vertical height 6·9-7·7, length of base 9·0-11·0. Second dorsal fin: vertical height 5·0-6·0, length of base 5·3-5·9. Length of dorsal spines: first dorsal spine 6·7, second dorsal spine 4·2. Concealed portion of dorsal spines from the base: first dorsal spine 3·5-3·9, second dorsal spine 2·1. Spiracle: width 2·1, length 1·3-1·7. Caudal fin: upper margin 18·4-19·0, lower anterior margin 9·0-10·1. Pectoral fin: outer margin 10·7, inner margin 14·1, distal margin 11·9-12·6. Distance from snout to: first dorsal origin 33·8-34·2, second dorsal origin 70·2, upper caudal 78·6-84·5, pectoral 25·4-27·2, pelvic 57·0-59·3. Inter space between: first and second dorsal 25·6-26·7, second dorsal and caudal 6·9-8·0, origin of pelvic and caudal 17·8-18·5. Distance from origin of: pectoral and pelvic 32·6-33·1, pectoral and caudal 54·5-57·7, pelvic and caudal 22·4-22·7. Pelvic fin: outer margin 7·4, inner margin 6·4-6·5, distal margin 8·5-9·0.

Trunk stout, posterior end tapering; snout pointed, head flat. Length of snout much shorter than that of distance between mouth and pectoral origin. Head with well developed sensory pores: dorsally supra-ophthalmic ampullae originates anterior to endolymphatic duct and communicates ventrally with the infra-ophthalmic ampullae which extends posteriorly as hyomandibular ampullae; mandibular ampullae and infra-spiracular ampullae are represented by a few pores on ventral side (Fig. 1 B). Endolymphatic ducts in the middle of interspiracle space. Labial folds at the corners of mouth, anterior labial fold short, posterior one long and deep.

Teeth distinctly asymmetrical in both jaws, $\frac{19+1+19}{19+1+19}$, upper jaw teeth erect, pointed with one cusp, uniform in size along the jaw; lower jaw teeth quadrate, each overlapping the next at outer edge, one broad sharp cusp so strongly oblique that its inner margin forms a continuous cutting edge parallel to the jaws; two series of functional teeth in upper and lower jaws and 4-5 series of non-functional teeth in both jaws (Fig. 1 F, G, H, I). Nostrils more or less horizontal, near to snout end than to mouth, inner margin drawn into pointed flaps (Fig. 1 E). Dermal denticles not closely spaced, exposing skin, rectangular without any spine or flap (Fig. 1 J). Spiracles large close behind orbit, divided into posterior and anterior chambers by a median septum; about twenty-four well developed spiracular filaments on inner side of median septum, each filament with an upper and lower lobular ends (Fig. 1D). Eyes large, oval. Gill slits gradually increase in length from first to fifth, first to third slits evenly spaced, fourth and fifth close together, upper end of fifth gill slit extends over the middle of pectoral peduncle ; gill arch with one short, pointed gill raker medially on the posterior side (Fig. 1C).

First dorsal fin behind the pectoral origin, apex round, posterior margin elongated ; first dorsal spine pointed, partly concealed, grooved on its inner side medially. Second dorsal behind pelvic fins, apex round, posterior margin produced ; spine pointed, partly concealed with a groove on inner side, and its tip with slight enlargement laterally. Smith (1961) reports an arrow-head-like enlargement on the tip of second dorsal spine. Anterior margins of pectoral and pelvic fins round, inner margins elongated ; inner margins of pectoral reach end of first dorsal base. Anal fins absent. Caudal with a sub-terminal notch, upper and lower margins round.



Map. Distribution of *Centrophorus armatus* (Gilchrist) and *Scymnodon rossi* (Alcock).

Colour : Dark brown dorsally, light brown ventrally, posterior margins of gill flaps tinted black.

Distribution : South Africa, Mozambique, west and east coasts of India. Though Smith (1961) states that ' only few specimens ever found from fairly deep waters'. In spite of being a bathypelagic species its distribution is restricted to the western and central Indian Ocean (15°N-35°S, 20°E-80°E) probably due to the 20° mean annual isotherm as indicated by Misra & Menon (1955).

Material: Two specimens, 935 mm, Female; Gulf of Mannar (08° 50′N, 79° 05′E), 220 fathoms, Trawl net; 22-iii-70 CMFRI. F. 199/633a and b.

Economic importance: Though the deep sea sharks are not favourably considered in the market, they are bound to become popular, as in other countries, when people become familiar with it. Silas (1969) found that vitamin A potency of liver of the species is very low compared to other commercially important sharks. According to Silas (op. cit.) percentage oil in liver varies from 69·4-72·5, and vitamin A potency of liver oil from 90·0-103·0 (usp./gm of oil).

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MANDAPAM CAMP, S. LAL MOHAN
TAMIL NADU,
December 7, 1970.

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15. A NOTE ON THE LOCATION OF BREEDING PITS OF *MYSTUS SEENGHALA* (SYKES) IN JAMONIA TANK NEAR BHOPAL

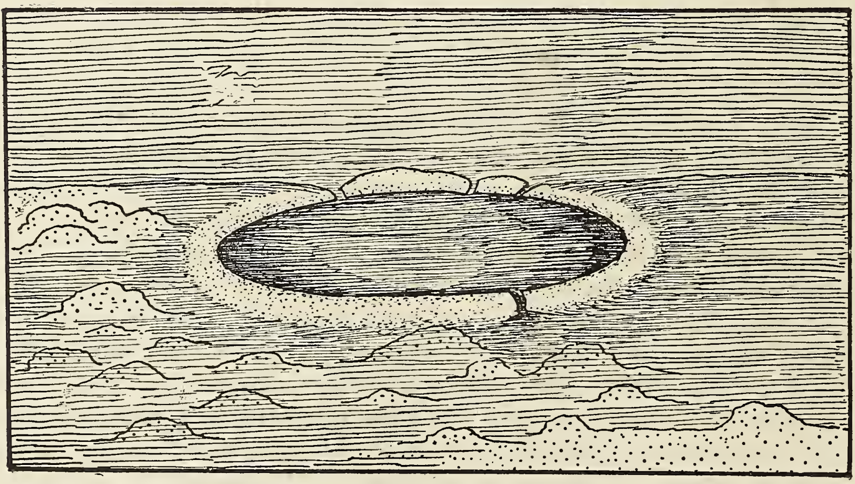
(*With a text-figure*)

The breeding pits of *Mystus seenghala* (Sykes) and *Mystus aor* (Hamilton) are quite well known. Raj (1940) recorded for the first time that these species prepare nests among rocks on the stream bed of Cauvery River in April and May. Saigal & Motwani (1961) found *M. seenghala* making nests in March on soft muddy bed in Ganga River near Allahabad. Recently Bhatt (1970), based on his enquiry from fishermen, has inferred that *M. seenghala* makes pits and spawns from April onwards in a 'lake' adjoining the Ganga in Dist. Farukhabad (U.P.). This 'lake' gets connected to the Ganga during monsoon months, but separates off into a number of ponds in summer months. This happens to be the first report on *M. seenghala* breeding in impounded water. Though the breeding of *M. seenghala* in rivers has been reported by other workers also, Khan (1934), Chacko & Kuriyan

(1948), etc., there is no reference available on breeding of *M. seenghala* in tanks except Bhatt's report (loc. cit). Therefore, the breeding of *M. seenghala* in the Jamonia tank near Bhopal has been described in this note.

The Jamonia tank is a perennial irrigation tank located in Sehore district about 40 kilometres from Bhopal, and has a recorded water area of 420 hectares. This tank was constructed by erecting a wall across the Jamonia nala, which, along with other small nalas draining the catchment area, brings water to this tank during the monsoon. The water from the tank flows down through the waste weir back to the old course of Jamonia nala, which later on joins River Parvati—a tributary of River Chambal of the Gangetic system. *Bundh* type breeding of major carps occurs in this tank on a large scale every year during the monsoon and a good number of major carp eggs are collected by the State Government. From November to June, there is not much flow of water from the nalas and during this period an almost dry condition prevails in this area.

This tank also has a good population of *Mystus seenghala* and *Wallago attu*, with the former contributing to a fishery of appreciable magnitude. The availability of both the adults and juveniles of *M. seenghala* in large numbers pointed to the definite possibility of the fish breeding in the tank itself. Therefore, the basin of the tank was surveyed in June, 1966, with a view to gather evidence of the breeding of *M. seenghala*. Due to extreme drought conditions, the water area of the Jamonia tank was reduced to about 1 to 2 hectares only, the maximum depth being only 2 to 3 metres. In the shallow marginal exposed area of the tank, a good many circular saucer-shaped depressions were observed in the mud (Fig.).



Breeding pit of *Mystus seenghala* (Sykes)

The formation of these depressions in the bed of this tank was reported to be an annual feature during summer. The sizable fishery of *M. seenghala* inclusive of its juvenile fishery, absence of *M. aor*, lack of nest building habit in *W. attu* and the previous reports from local fishermen seem to confirm that these depressions are the breeding pits of *M. seenghala.* The diameter of these pits varied from 0·6 to 1·2 m, with the depth ranging from 20 to 45 cm at the centre. The breeding pits observed by Saigal & Motwani (loc. cit.) in the Ganga were sandy depressions in waist deep areas 8-12 m from the shore and measuring about 0·9 to 1·2 m across and 25 to 45 cm deep at the centre.

Some of the isolated breeding pits containing water were also examined carefully, in an attempt to collect young ones from them, but no such collection could be made. But subsequently, a few dead and dried fry of *M. seenghala* (size 3 to 4 cm) were collected from one of the dry pits which tend to prove that these pits were utilised by *M. seenghala* for breeding and nursing the young ones. A few of the adult specimens of both sexes examined were found to be spent, indicating that the breeding was over by June. The knowledge of occurrence of breeding pits of this predatory fish in a tank will be of immense value in keeping its population in check by the destruction or removal of fry from these pits.

ACKNOWLEDGEMENT

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16. RAIN OF FISH IN SHILLONG, MEGHALAYA

(*With a photograph*)

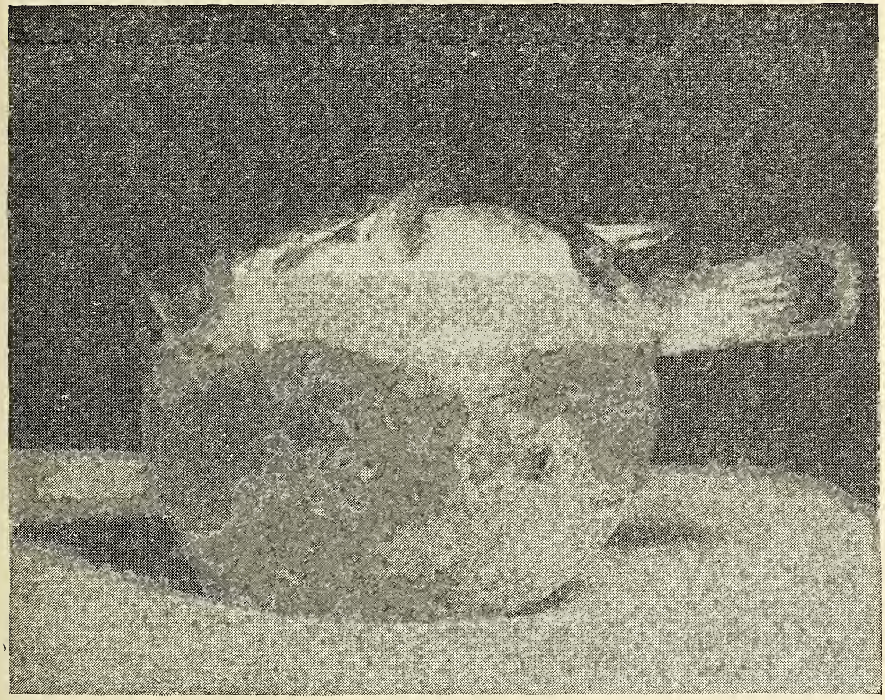
Following a severe hailstorm and heavy rains on 10 April, 1971, one of us (SJSH) saw at about 1 p.m. a whitish object resembling a tennis ball, fall from the sky with a thud into the open courtyard. On closer inspection it was found to be a fish in a highly inflated condition. The fish was preserved and was later identified as the fresh water globe fish, *Tetradon cutcutia* (Ham.). Although dead, it was in a very fresh condition and did not have any marks of injury. It measured 106 mm in length, 75 mm in width and had a displacement volume of 160 cc.

Tetradon cutcutia does not occur in the Khasi-Jaintia Hills of Meghalaya. This rules out the possibility of the fish having been dropped by a bird in flight. It could only have fallen from the sky with the rain and such instances of rain of fishes, although rare, are on record. Gudger (1921, 1929) has recorded 71 instances of rains of fishes from 15 countries all over the world. Hora (1933) has compiled a list of rains of fishes that occurred in India including East Bengal up to the year 1933 and has identified as far as possible the various species. The list is given below, with the current names of the species in parenthesis.

Barbus (*Puntius*) *sophore*=[*Puntius sophore* (Ham.)]
Ophicephalus gachua=[*Channa orientalis* (Bl. & Sch.)]
Ophicephalus striatus=[*Channa striatus* (Bl.)]
Ophicephalus marulius=[*Channa marulius* (Ham.)]
Esomus danricus=[*Esomus danrica* (Ham.)]
Chela bacaila=[*Oxygaster bacaile* (Ham.)]
Cerrhina mrigala=[*Cirrhinus mrigala* (Ham.)]
Amblypharyngodon mola (Ham.)
Mastacembelus pancalus (Ham.)
Cyprinus spp.

According to Hora (loc. cit.) the part of the country below Nepal, from Muzaffarpur in the east and Meerut on the west with Jhansi, Allahabad and Banares forming the southern boundary is the most suitable area for rains of fishes although such instances are available from the western coast (Kathiawar, Bombay and Poona), West Bengal (Dum Dum, Burdwan, Kharagpur and Sundarbans) and East Bengal (Dacca and Sylhet). The easternmost part where it has rained fishes is Sylhet in East Bengal, very near to the Meghalaya border.

Various reasons are attributed for the phenomenon. The most tenable explanation is that it is brought about by the action of high winds, whirlwinds and water-spouts. The presence, sometimes, of fishes that normally live in mud is indicative of the force with which water is sucked up to form the water-spout.



Tetradon cutcutia

The available records show that all rains of fishes have occurred in plains or places with low elevation. Thus the present rain of the globe fish at Shillong with an altitude of about 5000 ft. (1524 metres) is of considerable interest. It is also significant that *Tetradon cutcutia* does not occur in the hills of Khasi-Jaintia, but is known from the neighbouring plains only. We are inclined to believe that the fish was lifted up from the plains of East Bengal and deposited at Shillong through the agency of the prevailing winds. The fact that the Meteorological wing of the Military Airport at Shillong recorded a strong wind with a velocity of 25 to 30 Knots on the forenoon of 10th April from a south-westerly direction lends support to this. Standing at the border town of Mawblang (Cherrapunjee) one can well understand how this could have happened. The plains of East Bengal are visible down below to the south, stretching as far as the eye could see. The steep incline of the hills here would lift up the winds blowing from East Bengal almost vertically to great heights. One of us (RSP) who on that day happened to be near Dudhnai (*c.* 150 km west of Shillong) in the plains district of Garo Hills on a collection tour, experienced a very strong gale and was compelled to take shelter under a bridge. The wind came from the south-west.

Had the fish been floating in the puffed state in which it was picked up, it would have been very easily lifted up by a strong wind or whirlwind. If, on the other hand, it were swimming normally, the formation of a water spout alone would have explained its transport. The aerial mode of transport would naturally have agitated the fish resulting in its inflated condition.

Most of the rain of fishes have occurred during the monsoon months July to September, although there have been exceptionally heavy fall of fishes at Dacca in February, 1830 and Fatehpur in May, 1834. The general belief that the fishes come down usually in the middle of the day with a final heavy shower appears to be true.

The present one is the first record of rain of fishes for the North-eastern part of India (Assam and Meghalaya) and *Tetradon cutcutia* is being recorded for the first time in a rain of fishes.

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17. THE NOMENCLATURAL STATUS OF *HETEROMETRUS* AND *PALAMNAEUS* (SCORPIONIDAE)

Ehrenberg and Hemprich (1828) introduced into the literature a new subgenus *Heterometrus* of the genus *Buthus* represented by two new species *Buthus* (*Heterometrus*) *palmatus* and *B.* (*H.*) *spinifer.* The type localities of the former were given as Libya, Arabia and Syria (near Alexandria in Mount Sinai and in Mount Lebano). The single specimen upon which *B.* (*H.*) *spinifer* was described came as a gift from an Alexandrian physician, a Dr. Mopurgo, who brought it back dead from India.

In contemporary systematics these two species are recognized as belonging to two different genera in the family Scorpionidae. The question as to which of these two species should be the type species of *Heterometrus* has been the center of disagreement for about one hundred years.

Gervais (1844), in his relatively large work, simply lists *Buthus* (*Heterometrus*) *spinifer* E. & H. from India and adds to the original description from specimens taken on the Malabar Coast. These specimens had only eleven pectinal teeth whereas the original specimen had 19 and 20.

Peters (1861), in a discussion of some scorpions from Mozambique raises *Heterometrus* to a genus but lists only one species, *H. palmatus* E. & H.

Simon (1872) agrees with Peters in removing the *Heterometrus* from the genus *Buthus* in which it was originally placed. However, in his revision of the *Heterometrus* group he, understandably, fails to mention *B.*(*H.*) *spinifer* E. & H. but curiously includes both African and Indian forms in his *Heterometrus.*

Thorell (1876) is the first to distinguish between the African and Indian forms. He recognizes the genus *Heterometrus* and declares *Scorpio maurus* Linn. 1758 as the type-species and *H. palmatus* (E. & H.) as a synonym of this species. The Indian forms are placed in a new genus *Palamnaeus* with *P. petersi*, sp. n. as its species-type. Interestingly enough he discards *B.* (*H.*) *spinifer* E. & H. as a doubtful species because of the high pectinal tooth count (19 and 20) reported in the original description.

Karsch (1879) points out that Thorell erred in forming the genus *Palamnaeus.* He states that Thorell failed to recognize the genus *Scorpio* (1758) in his revision of the entire order even though he declared *Scorpio maurus* Linn. 1758 as synonymous with *Heterometrus palmatus* (E. & H.) and the type-species of his genus *Heterometrus* (E. & H.). Therefore, the Thorell concept of *Heterometrus* (E. & H.) must give way to the older genus *Scorpio* Linn. which will contain *Scorpio maurus.* This leaves *Heterometrus* (E. & H.) with the one remaining species *spinifer* E. & H. The taxon represented by this species was declared by Thorell as the genus *Palamnaeus*. However, the genus *Heterometrus* (E. & H.) was still available and, therefore, *Palamnaeus* must be considered as a synonym of *Heterometrus* (E. & H.) 1828, with *H. spinifer* (E. & H.) 1828, as the type-species.

Pocock (1892a), without referring to the paper of Karsch, declares that Thorell's *Palamnaeus petersi* is a synonym of *B.* (*H.*) *spinifer* E. & H. and, therefore, the type-species of the genus *Palamnaeus* Thorell. In another paper (1892b) he refers to *P. spinifer* and *P. thorelli* but places other members of this taxon in the genus *Scorpio* Linn.

Kraepelin (1894), also apparently disregarding Karsch's paper, retains the taxonomy of Thorell but recognizes *H. palmatus* (E. & H.) as a valid species distinct from *Scorpio maurus* (Linn.) 1758, and treats *B.* (*H.*) *spinifer* E. & H. as a synonym of *Scorpio longimanus* Herbst, 1800, along with several other species of *Palamnaeus*.

Pocock (1896) retains the name *Palamnaeus* (type *petersii*) and clearly differentiates it from the genus *Scorpio* (type *africanus*). Regarding the *Palamnaeus* type he states, '*Petersii*—probably identical with *spinifer*, E. & H., and possibly with *longimanus*, Herbst.' He continues to recognize the genus *Heterometrus* as an African taxon.

Kraepelin (1899), in DAS TIERREICH, treats *Palamnaeus* as a synonym of *Heterometrus* which includes only the taxa of India and Indo-China. Interestingly, however, he considers *B.* (*H.*) *spinifer* E. & H. as a synonym of *H. longimanus* (Hbst.) 1800, and *H. palmatus* E. & H. now is considered as a synonym of *Scorpio maurus* Linn., 1758.

Pocock (1900) criticises Kraepelin's adding *Heterometrus* to the synonymy of *Scorpio* and the placing of *palmatus* in the synonymy of *maurus*. Accordingly, he recognizes *palmatus* as a valid species of *Heterometrus* E. & H. and does the same for *maurus*. Pocock's concept of *Heterometrus* contains eight species against two in Kraepelin's *Scorpio*. Essentially Pocock has repeated the condition to which Karsch referred in 1879 (above) by not recognizing the genus *Scorpio*.

In his greater work on the scorpions of India (1900) Pocock continues to use *Palamnaeus* as the genus name for the Indian taxon and listing as synonyms *Scorpio* and *Heterometrus*. Again he seems to ignore Karsch and recognizes sixteen species in the genus.

Simon (1910) continues to recognize *Heterometrus* as an African taxon and *palmatus* E. & H. as a valid species with *Scorpio maurus* in its synonymy. He seems to choose to ignore Karsch's revision.

Kopstein (1921) accepts the genus *Heterometrus* as representing the Indian taxon. In the synonymy of *Heterometrus longimanus* (Hbst.) he lists *Palamnaeus longimanus* and *P. spinifer*.

Meise (1932) and Werner (1934) accept the genus *Heterometrus* as representing the Indian taxon and give *Palamnaeus* as a synonym.

Vachon (1952) recognizes *Scorpio maurus* as the valid name and drops the designation of *Heterometrus* and recognizes the various forms of *B.* (*H.*) *palmatus* as subspecies of *Scorpio maurus* without retaining the name *palmatus*.

Thus following the reasoning of Karsch, since *B.* (*H.*) *palmatus* is removed from *Heterometrus* (E. & H.) the genus name must be applied to the remaining species *B.* (*H.*) *spinifer* E. & H. and the type species is *Heterometrus spinifer* (E. & H.). (Code 69B, example 3, choice by elimination).

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18. NEW RECORDS OF NITIDULID AND RHIZOPHAGID BEETLES ON MAIZE COBS IN THE U.P. TARAI

During a survey of maize crop in the years 1966-68 at Pantnagar and the adjoining areas of Tarai, larvae of some Nitidulid and Rhizophagid beetles were seen feeding on maize cobs, on and between the grains from the tip to the butt end. Such cobs gave a very offensive smell, making them unfit for marketing. The larvae which were collected and reared on healthy green cobs were identified as of *Carpophilus obsoletus* Er., *C. mutilatus* Er. and *C. marginellus* Mots (Nitidulidae : Coleoptera) and *Europs depressus* Gouv. and *Haptoncus* (*Epuraea*) *luteolus* (Er.) (Rhizophagidae : Coleoptera).

Carpophilus spp. and *Haptoncus* spp. have long been known to lead a saprophytic existence. In general they feed on decaying fruits and other plant parts as well as on the fermenting ' sap flows ' of many tree species, on animal matter and raw sugar. The insects have also been recorded as pests of stored cereals, peanuts, dried maize, sesamum, maize cobs and dried fruits. Lefroy (1909) recorded *C. dimidiatus* var. *mutilatus* Er. on borer holes of canes and sorghum and on the flowers of cotton. Agrawal (1958) reported *C. mutilatus* and *Haptoncus luteolus* (Er.) as occurring in large numbers beneath the leaf sheath on sugarcane and feeding on the sap which oozed due to the feeding of the sugarcane mealy-bug, *Saccharicoccus sacchari* (Ckll.). The beetles were always found associated with the mealy-bugs and were attracted by the sap but caused no apparent damage. In the Pantnagar and surrounding area they cause light to moderate damage to the grains of maize. The cobs whose sheaths were destroyed by birds or those not fully covered with the sheath, were mostly damaged. It is probable that the maize grains in the milky stage attract beetles for feeding and breeding.

We have not come across any reference to these beetles as pests of maize in India and perhaps this is the first record. Other Nitidulids namely, *Carpophilus lugubris*, *C. humeralis*, *C. freemani*, *C. hemipterus*, *Glischrochilus fasciatus* and *G. quadrisignatus quadrisignatus* including *Carpophilus marginellus* have been reported as pests of sweet corn under field conditions in North Carolina, U.S.A. (Daugherty & Brett 1966).

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19. A CONVENIENT METHOD OF REARING TIGER BEETLES (COLEOPTERA : CICINDELIDAE) IN THE LABORATORY FOR BIOLOGICAL AND BEHAVIOURAL STUDIES

The authors have been making observations on the biology and behaviour of the tiger beetle, *Cicindela cancellata* Dej., and in this connection, the following rearing method was found to be very satisfactory.

A glass specimen jar, 20×20×40 centimetres is used as the rearing jar. It is filled with washed sand which has been sifted through a wire gauze with about 36 meshes per square centimetre, to a height of about thirty centimetres. The sand is kept moist by sprinkling about 100 ml of water twice a week regularly. The jar is preferably placed on a table in an open verandah so that it may be exposed to direct sunlight at least once a day, in the forenoon or in the afternoon. The observations of the authors suggest that a certain amount of strong and direct sunlight is necessary for the normal life and activities of tiger beetles.

The jar is provided with a lid of plastic gauze with about 49 meshes per square centimetre, fixed on a heavy wooden frame. Plastic gauze is preferred to wire gauze which will go rusty in course of time due to sprinkling of water through it. A gauze of fine mesh is selected in order to prevent the escape of small insects which are offered to the beetles and their larvae as food. The gauze-lid also serves the purpose of a ventilator and also prevents excessive humidity and moisture in the sand.

About a dozen adult tiger beetles including both sexes are introduced into each jar. They are offered as food, nymphs of grasshoppers, bits of grasshoppers and leafhoppers collected with a sweep-net over grass. Once in two days, the surface of sand in the jar should be cleaned by removing the remains of dead food-insects and dead beetles. The beetles seem to thrive well under this arrangement. They soon start mating and laying eggs in the sand.

In course of time, the eggs hatch into larvae and small circular openings of the larval burrows appear on the surface of sand. The highly predaceous larvae catch the leafhoppers and feed on them. They grow and pass through metamorphosis and generation after generation of these beetles can be reared and maintained successfully in this manner. A few of the eggs are laid very close to the walls of the jar and the larvae hatching from them invariably excavate their burrows close to the walls of the jar. Though some of these burrows take their course to the interior of the jar, occasionally, a few of them are excavated directly along the inner surface of the wall which therefore forms part of the inner surface of the burrow itself. In such a case, the interior of the entire burrow from top to bottom can be clearly seen through the transparent glass wall. This situation gives the worker an excellent opportunity to observe the behaviour of the larva inside the burrow, particularly relating to the method of excavation of the burrow, locomotion and feeding. The course and structure of the burrows can also be studied. The behaviour of the adult beetles can also be easily observed through the walls of the jars.

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20. CANNIBALISM IN THE COFFEE BEAN WEEVIL *ARAECERUS FASCICULATUS* DE GEER (COLEOPTERA : ANTHRIBIDAE)

Among coleopterous pests of stored products, egg cannibalism has been studied in detail and in relation to population density in the flour beetle, *Tribolium confusum* Duval by Boyce (1946)[1]. The coffee bean weevil, *Araecerus fasciculatus* De Geer, which is a serious pest of stored coffee bean, arecanut, tapioca chips, grains etc., also exhibits cannibalistic tendency under certain conditions. The adults have been observed to eat the eggs as well as the adults of their own species in the rearing jars in the laboratory. The factors which prompt a small fraction of the population of these beetles to resort to cannibalism are not clear as they have been observed to do so even in the presence of abundant food, living space and at low densities. In a rearing jar of two litre capacity containing 25 beetles and supplied with 10 grammes of food, about two or three beetles tended to be cannibalistic. In a case which was watched, a beetle seized another from the front. At the beginning, the two faced each other. The cannibalistic beetle held the other with its legs and started nibbling and biting it in the cervical region repeatedly. After repeated attacks which were accompanied by a considerable amount of struggle, the prey beetle was immobilised, after about 15 minutes. Other beetles in the jar which happened to come into contact with the dead beetle apparently showed no inclination to feed on it. The preying beetle then turned over the body of the dead beetle, exposing its ventral side and started consuming it from the abdominal region. After feeding for about 15 minutes, the beetle deserted the prey, leaving behind only its head, thorax, wings and some cuticular parts of the abdomen.

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[1] BOYCE, J. M. (1946): The influence of fecundity and egg mortality on the population growth of *Tribolium confusum* Duval. *Ecology*, **27**: 290-302.

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21. A SIMPLE CASE OF LEARNING IN THE ANT, *CAMPONOTUS* SP., (HYMENOPTERA : FORMICIDAE)

Though the intelligence of ants in the strict sense is limited, their capacity to learn from experience or training in artificial nests in the laboratory can be assessed by a number of tests such as those listed by Skaife (1961)[1]. The authors have been maintaining a colony of the ant, *Camponotus* sp., in an artificial nest designed by them out of a circular plastic container, for the past six months and have observed the following simple but interesting instance of learning in this ant.

The ant mentioned above is in the habit of dumping rubbish consisting of remains of food, exuviae of larvae, dead ants, and excremental pellets into a few small heaps, a little distance away from a corner of the artificial nest where the members of the colony congregate. The authors tried to train the ants to collect and dump the rubbish matter in one place. Therefore, the rubbish from all the heaps was collected and put by the authors, inside a shallow, small container at one end of the nest away from the side where the colony had settled down. Then, whenever the ants put the waste matter anywhere else in the nest, it was collected by the authors and put inside the shallow container which was meant to be used eventually by the ants for dumping rubbish. Within a few days the ants started throwing more waste matter into the concerned container than anywhere else inside the nest and within about two weeks, they developed the habit of dumping the rubbish exclusively into the container kept for the purpose. The olfactory factor must have played an important role in this learning process. Later, when a few small bits of paper were littered inside the nest one evening, the ants, by the following morning, had already collected and thrown them into the rubbish container.

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[1] SKAIFE, S. H. (1961): The study of ants. Longmans, Green and Co. Ltd., London, pp. 178.

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22. LARVAL PARASITES OF *PSEUDALETIA SEPARATA* (WALKER)

Pseudaletia separata (Walker) is an important pest of graminaceous crops including sugarcane, maize, jowar, rice and grasses. During the course of investigation on its biology at R.A.K. College of Agriculture, Sehore, Madhya Pradesh, in 1964, attempts were made to study its natural enemies. No predator could be recorded during the study but cannibalism amongst the caterpillars was noticed.

Out of the 200 caterpillars collected from the field during October, 70% were found to be parasitised. The adults of different parasites that emerged from the above sample were 548 *Apanteles ruficrus* Haliday, 21 *Disophrys* sp.; 9 *Rhogas* sp.; 3 *Dolichocelon paradoxum* B.B. and 5 *Exocrista fallax* Mg. This indicates that *A. ruficrus* is the dominant parasite at Sehore.

Out of the above parasites *A. ruficrus* (Braconidae) has been recorded earlier on the pest by Khan (1946) and Bhatnagar (1948). Other parasites recorded previously in India on *Pseudaletia* are *Actia monticola* Mall, *Cyphocera* (*Cyphocera*) *varia* F., *Sturmia inconspicuoides* Baranov (Cherian & Ananthanarayanan 1941), and *Parasierola* sp. (Avasthy & Chaudhary 1963), which were not recorded by the authors at Sehore.

The parasites, *Rhogas* sp., *Disophrys* sp. both Braconids and *Dolichocelon paradoxum* B.B. and *Exocrista fallax* Mg. both Tachinids have been recorded for the first time in India on the pest.

ACKNOWLEDGEMENTS

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23. A NEW RECORD OF ALTERNATE HOST OF ARMYWORMS

Armyworms, *Pseudaletia separata* Walker and *Cirphis loreyi* Duponchel have been reported as major pest of paddy (Fletcher 1917; Katiyar & Patel 1969). In India armyworms have been observed to feed on various other crops including maize, jowar, wheat, sugarcane (Fletcher 1917), gram, linseed and mustard (Singh & Sinha 1965). Besides these crops their occurrence has been noted on grasses, fodder and green manure crops (Ayyar 1963). Kadam & Patel (1960) described bajra and other cereals as its host plants, while Fletcher (1917) found them on ' kodon ' (*Paspalum scrobiculatum*) and oats.

Apart from these, the armyworms have been found to attack timothy, flax, barley, buckwheat, rye, cranberry, some legumes and several grasses in other parts of the world.

In Raipur district of Madhya Pradesh, larval stages of both *P. separata* and *C. loreyi* have been found to feed on a weed, *Eriocaulon sexangulare*. The weed grows profusely in the paddy fields in this locality. When the weed was provided to the caterpillars of armyworms it was readily accepted by them for food. Similarly, caterpillars feeding on weeds readily migrated and normally fed on paddy plants in the laboratory. It was felt that the earlier stages of the caterpillars prefer this weed to paddy plants. Later they migrate from the weed to the crop. Large number of caterpillars were collected from this weed for laboratory studies.

Eriocaulon sexangulare appears to be the first record as an alternate host of *P. separata* and *C. loreyi.*

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24. PRELIMINARY OBSERVATIONS ON USE OF 'MALARIAL "B"', A LARVICIDAL OIL IN THE CONTROL OF AQUATIC INSECTS IN NURSERY PONDS

The occurrence of notonectids, *Anisops* spp., which prey upon and destroy large numbers of young carp fry in nursery ponds, is a common menace in pond culture operations. Pakrasi (1953), while devising the method of oil emulsion treatment, has shown that mustard oil emulsified with soap solution, 50 lb. per acre as standard dose, is very useful in controlling aquatic insects in ponds. Konar (1964) has recommended DDVP as a cheap, suitable and selective toxicant for the eradication of insect predators. In India, as proposed by Pakrasi (op. cit.), mustard oil is being extensively used everywhere as an insect killer in the preparation of carp nurseries. But now on account of the high cost of mustard oil its use in oil emulsion treatment is not economical. The search for cheaper and suitable substitute for mustard oil led to the successful employment of a mineral oil during nursery preparation at the Government Fish Farm, Bhopal (M.P.). This oil is dark brown in colour and is manufactured by Indian Oil Corporation under the commercial name 'Malarial "B"', and costs only 35 Paise per litre. As the name indicates this larvicidal oil is being commonly used in antimalarial work, for controlling mosquito larvae in ponds and ditches.

With a view to judge the efficacy of this mineral oil on aquatic insects, laboratory experiments were conducted in galvanised iron tubs measuring 65×65×45 cm, with a surface water area of 0·4 sq metres. The treatment with the oil was tried in three dosages of 40, 50 and 55 litres per hectare. The dose of 50 litres per hectare was found to be satisfactory.

The test insects used for this experiment were *Anisops* spp., *Ranatra* sp., *Nepa* sp., beetles, water bugs and dragon-fly nymphs, among which the notonectids were the first to be affected in all the three cases. Their complete kill in the dose of 50 litres/hectare was observed in 35 minutes, as against 120 minutes as maximum time taken by *Nepa* sp. The zooplankton, fish spawn and fry released in experimental tubs were not adversely affected. The complete kill of *Anisops* spp. and *Ranatra* sp., with the standard dose of mustard oil, which was also tried simultaneously in the laboratory, was found to take 50 minutes thereby showing that 'Malarial "B"' is as effective as mustard oil. Though the higher dose of 55 litres/hectare gives quicker effect, the dose of 50 litres/hectare is found to be comparatively economical. No insects other than notonectids were affected in the lower dose of 40 litres/hectare. The results of laboratory experiments are given below in Table I.

TABLE I

EFFICACY OF 'MALARIAL "B"' ON AQUATIC INSECTS

Dose per hectare of water surface (litres)	Time taken for complete kill of insects (minutes)								Cost of treatment (per hectare) Mustard oil
	Anisops spp.	*Ranatra* sp.	*Nepa* sp.	Beetles	Water bugs	Dragonfly nymphs	Mustard oil (standard dose)	Malarial 'B'	
								Rs.	Rs.
40	90	—	—	—	—	—	—	14·00	
50	35	90	120	not used	90	80	50[1]	17·50	30·00
55	25	60	90	60	60	60		19·25	

The efficacy of the lower dose of 40 litres/hectare was subsequently confirmed by field trial in nursery pond, when complete kill of insects, mostly notonectids, was observed in 60 minutes (*see* Table II). Thus the dose of 40 litres/hectare appeared to be quite sufficient for complete eradication of notonectids, which are more commonly encountered in nursery ponds. Further field trials with higher doses could not be made due to inadequate sample of oil, but on the basis of laboratory experiments it can be inferred that the dose of 50 litres/hectare can cause complete kill of all the insects present in nursery ponds. The dose of 40 litres/hectare will, however, serve the purpose exclusively for notonec-

[1] Only *Anisops* and *Ranatra* were used.

tids, while the higher dose may be given when other varieties of insects are also present in appreciable numbers.

TABLE II

EFFICACY OF 'MALARIAL "B"' ON AQUATIC INSECTS UNDER NATURAL CONDITIONS

			Reaction on insects (*Anisops* spp. and *Ranatra* sp. only)	
Water area of pond (m^2)	Dose per hectare (litres)	Quantity of oil used (ml.)	Time taken for majority kill (minutes)	Time taken for complete kill (minutes)
160	40	640	35	60

In the trials, the oil was poured along the four sides of the ponds and gradually spread to form a uniform thin film over the water surface. Unlike mustard oil, soap was not required and it was found that wind could not easily break the surface film when 'Malarial "B"' was used. As such, it is felt that the application of this oil may be effective on windy days as well.

It is evident from Table I that the cost involved in treating one hectare water area with 50 litres of 'Malarial "B"' comes to only Rs. 17·50, which is relatively low in comparison to the high expenditure (Rs. 300·00) involved in the use of mustard oil. It is at least as efficacious as mustard oil, has no harmful effect on zooplankton and fish spawn, takes lesser time for complete kill and is more resistant to wind action and is therefore an effective and economical substitute for mustard oil for control of aquatic insects in nursery ponds.

ACKNOWLEDGEMENT

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25. TREMATODE GILL PARASITES FROM THE FLYING GURNARD *DACTYLOPTENA ORIENTALIS* (CUV.) OF THE INDIAN OCEAN

(*With three text-figures*)

During the first scientific cruise (February to April 1963) of the United States Research Vessel *ANTON BRUUN* in the Indian Ocean, as part of U.S. Programme in Biology of the International Indian Ocean Expedition, I had the opportunity on two occasions to examine from the trawl collection specimens of Flying Gurnard fish for parasites. On 23 March, 1963, from the trawl collection at Station 20 (9° 13′N, 97° 51′E) off Phuket, three specimens of the fish *Dactyloptena orientalis* (Cuv.) were examined. The gills of the host though devoid of heavy mucous coating, showed infection by parasitic copepods and several specimens of monogenetic trematodes. The oesophageal and intestinal regions were occupied by digenetic trematodes. Two host specimens obtained from the trawl collection on 1st April, 1963 at Station 43 (15° 08′N, 94° 04′E) off Chittagong showed infection by the same species of monogenetic trematodes obtained on the previous occasion while the parasitic copepods of the gills and the Digenea of the intestinal organs were all absent. The monogenetic trematodes collected on both occasions belong to the same new species and new genus which is named *Glandulocephalus* gen. nov. and species *G. bruuni* sp. nov. and described below.

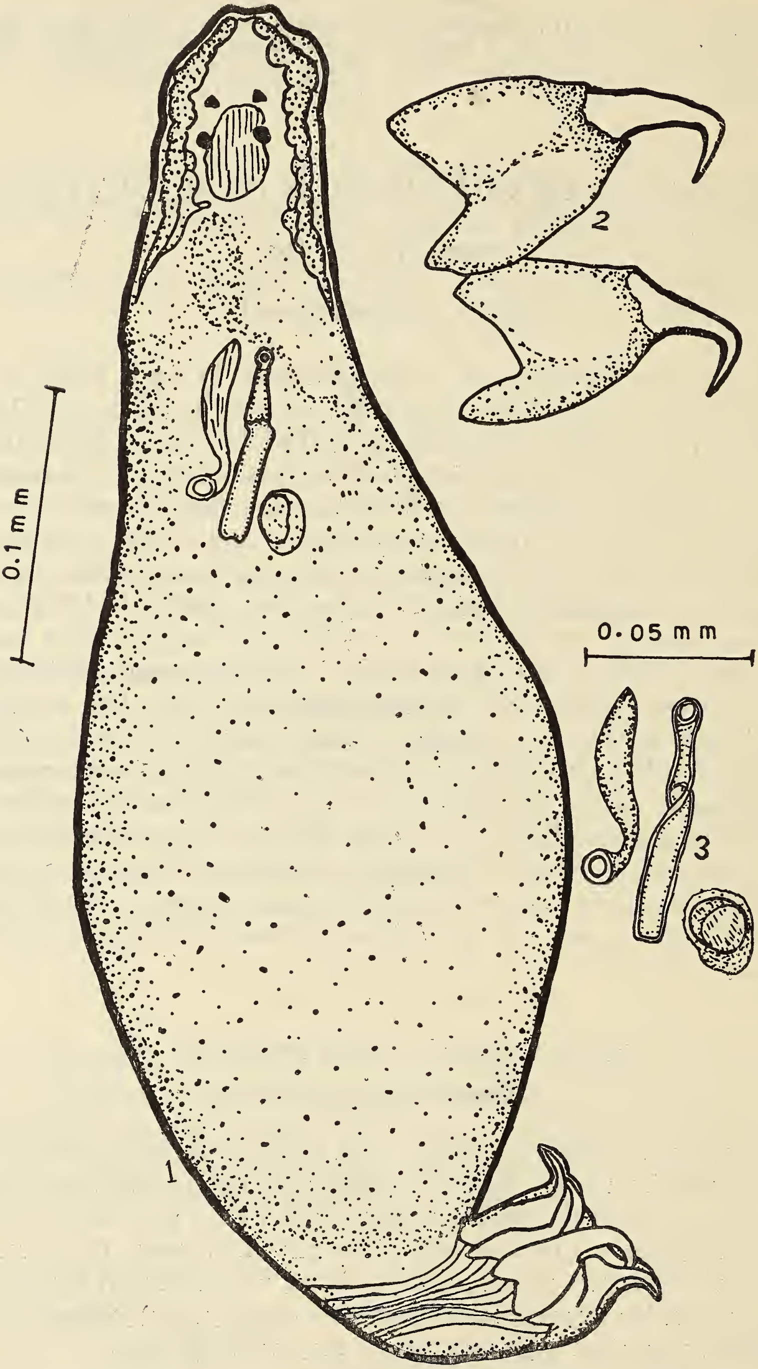
Family TETRAONCHOIDIDAE Bychowsky 1951

Glandulocephalus gen. nov.

Diagnosis: Tetraonchoididae, with a very small body; haptor well demarcated from body, with two similar pairs of large anchors, no haptoral bars, marginal hooklets scanty; head with a pair of lateral long cephalic glands one on each side of the pharynx towards the margin of the body; two pairs of eyes; pharynx large, crura confluent posteriorly; seminal vesicle present; male intromittent organ (cirrus) jointed, tubular and with a basal bulb; vagina may or may not be present.

Parasitic on the gills of marine fishes.

Genotype: *Glandulocephalus bruuni*



1. *Glandulocephalus bruuni* n. gen., n. sp., complete worm, dorsal view; 2. Anchors; 3. Male terminalia.

Glandulocephalus bruuni sp. nov.

(Figs. 1-3)

Body dorsoventrally flattened, very small, total length 0·52 to 0·58 mm, elongate oval, narrowing posteriorly to a blunt end ; cuticle thin and smooth. Prohaptor with a pair of irregularly lobed lateral cephalic glands along the pharyngeal region occupying a length of 0·065 mm on each side ; eye spots two pairs one behind the other, anterior pair smaller, all in the anterior half of the pharyngeal zone. Mouth mid ventral, anterior to the level of eye spots ; pharynx ovoid, 0·045 × 0·031 mm ; oesophagus short ; intestinal crura bifurcating in front of the male terminalia and confluent posteriorly behind the testes zone, in front of the haptor.

Haptor demarcated from body, with two pairs of similar large anchors, 0·065 mm long, wide and bifid at the base, shafts long and slightly curved, tip recurved ; haptoral bars absent ; haptoral hoods scanty.

Testes saccate, between the intestinal crura ; vas deferens widens to form a seminal vesicle on the left side of the male intromittent organ (cirrus complex) and enters the cirrus by a cirrus bulb at the base of the cirrus ; cirrus complex with a basal bulb and jointed tubular accessory cuticularised piece, 0·075 mm long opening out by the median male genital pore situated between the first and second quarter of the body. Ovary saccate, pretesticular, oblique ; oviduct wide, joins the ootype region ; ootype small ; uterus median ventral opens at the male genital pore ; vaginal pore and egg not observed.

Host : *Dactyloptena orientalis* (Cuv.) on the gills.

Locality : Off Phuket and Chittagong in the Indian Ocean. Several specimens collected on 23 March, 1963 and 1 April, 1963.

DISCUSSION

The genus *Glandulocephalus* closely resembles genus *Amphibdella* Chattin, 1874, in the absence of haptoral bars, the general shape of the body and the presence of similar anchors. The present species however, has a small body with very thin cuticle, haptor though distinct from body is not lobed or elaborately hooked as in *Amphibdella*. There are two pairs of eyespots and the male intromittent organ of the present species is by far different in structure than in *Amphibdella*. Also the head organs form a longitudinal lobed mass on either side of the pharynx in the present species instead of 3 distinct pairs. Moreover, the hosts are different for the two monogenoideans.

With *Ancyrocephaloides* Yamaguti, 1938, also the present species shows resemblance to a remarkable extent especially in the presence of symmetrical anchors, small body, absence of haptoral bars, confluent crura, eyes and head organs. But even in these organs the details differ considerably as described. The glandular vesicles of the haptor of *Ancyrocephaloides* are not observed in the present species. The two prominent lateral lobes of *Ancyrocephaloides* are not observed in the new genotype. The structure of the male terminalia are also widely different.

Glandulocephalus thus resembles *Amphibdella* Chattin, 1874, and *Ancyrocephaloides* Yamaguti, 1938, in many generic characters but is different from both in many other characters of generic importance. In the extreme smallness of the body and most of the generic characters it has more inclination to the *Ancyrocephaloides* type. Hence the new genotype is included in family Tetraonchoididae Bychowsky, 1951, of the order Tetraonchidea Bychowsky, 1957.

Generic name signifies the lateral cephalic glands of the worm and the species is named after the research ship from which the material for study was collected.

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I wish to express my gratitude to Dr. E. C. LaFond the cruise leader and the Scientists and staff on board the U. S. R. V. *ANTON BRUUN* during the first cruise of the International Indian Ocean Expedition, for all co-operation and help. I thank Dr. N. K. Panikkar, Director, National Institute of Oceanography for deputing me to the Research Vessel *ANTON BRUUN*.

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26. A NEW MONOGENETIC TREMATODE *SAURICOTYLE SPROSTONI* GEN. ET SP. N. ON THE GILLS OF THE LIZARD FISH *SAURIDA TUMBIL* (BLOCH) FROM THE ARABIAN SEA

(*With four text-figures*)

During the second cruise of *I.N.S. KISTNA* in the Arabian sea during the period 3rd to 14th November, 1962, with the International Indian Ocean Expedition, four specimens of the lizard fish *Saurida tumbil* (Bloch) were obtained from a trawl collection, off Bombay, on 14 November. Of these, the largest specimen harboured three specimens of a monogenetic trematode on its gills, while the other three were devoid of any ectoparasite. All three specimens of monogenetic trematodes were of the family Diclidophoridae, Fuhrmann, 1928, in essential characters but could not be accommodated in any of the existing species or genera of the family. Hence the specimens are assigned to a new genus *Sauricotyle* and species *Sauricotyle sprostoni* and described below. The generic name refers to the name of the host. The species is named in honour of Miss Nora G. Sproston whose constant guidance and encouragement have helped me considerably in my work on this interesting group of invertebrates.

Sauricotyle gen. nov.

Diclidophoridae, with an elongated 'plectanocotylid' body shape; haptor demarcated from body proper, with 4 pairs of clamps 4 on each side borne on long peduncles; clamp structure declidophorid with broad cuticularised sclerites abaxial and adaxial halves asymmetrical; terminal anchored lappet absent; testes numerous intercrural, post-ovarian; male terminalia armed with a simple cluster of recurved spines; male genital pore median ventral at the intestinal bifurcation; ovary inverted U-shaped; vitelline ducts present, vitellaria large, oral pouches larger than pharynx, oesophagus unbranched, crura confluent at the proximal level of the haptor.

Ectoparasitic on marine fishes.

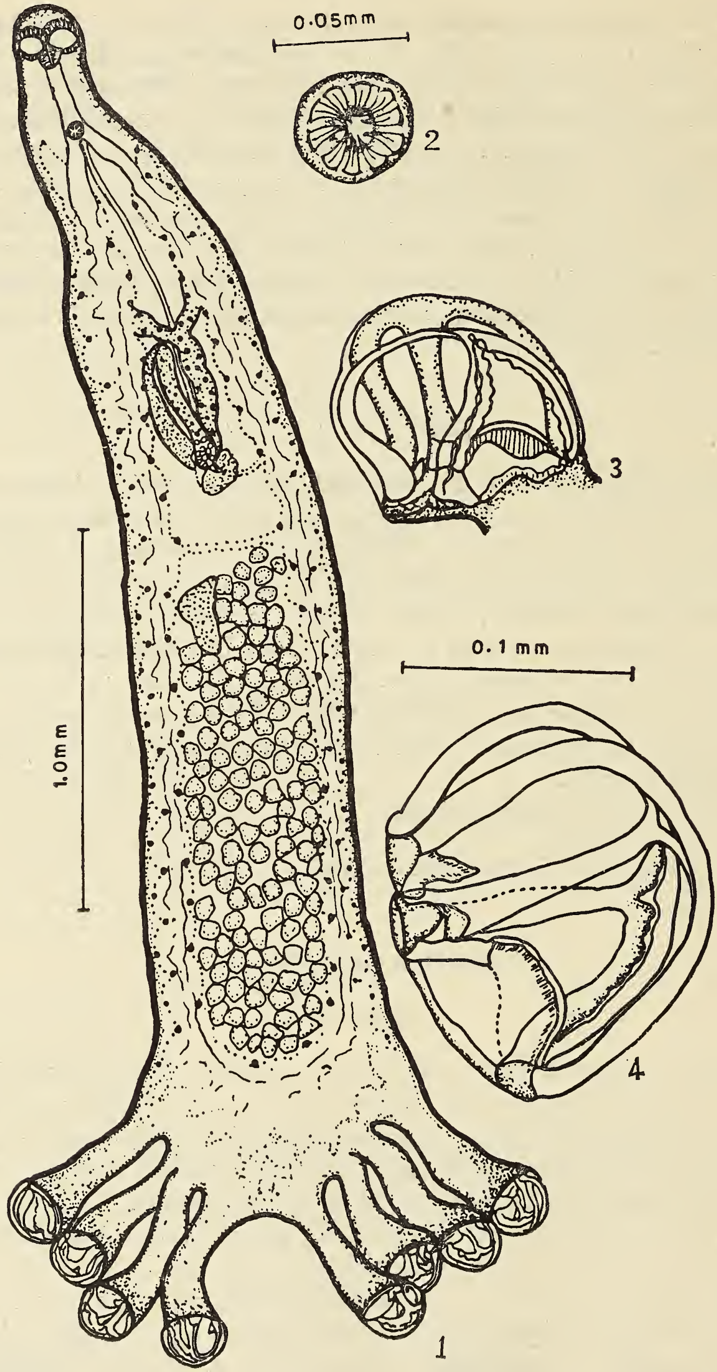
Type species: *Sauricotyle sprostoni.*

Sauricotyle sprostoni sp.nov.

(Figs. 1-4)

Body elongate, anterior and narrow, mid-body almost parallel-sided but widening at the haptoral base into the four pairs of long pedunculate clamps, four on each side separated medially by a wide cleft at the posterior end of the worm; total length 3·5 to 4·2 mm and maximum width 0·6 to 0·9 mm across the body at the base of the haptor.

Haptor, devoid of extensions of body organs, forms almost a quarter of the total body length, with four pairs of clamps, 4 on each side one behind the other borne on long slender peduncles; clamps almost similar in size, wider than long, 135×190 μ-145×200 μ, and essentially diclidophorid in structure, as shown in figures 3 and 4. The well cuticularised dorsal and ventral jaws are broad at the base near the articulation region and continuous distally. The dorsal and ventral arms of the broad



1. *Sauricotyle sprostoni* n. gen., n. sp., complete worm, dorsal view; 2. Male genital pore with the cluster of recurved spines; 3. One clamp, dorsal view; 4. Another clamp, ventral view.

U-shaped median spring is distally continuous with the curvature of the dorsal and ventral jaws of the clamp. The dorsal arms of the median spring has a frilled outer margin and the clamp has a convex additional piece of cuticularised sclerite on the abaxial half, articulated at the base between the median spring and the jaw sclerites. A similar sclerite is lacking on the adaxial half of the clamps, the abaxial and adaxial halves of the clamps are asymmetrical; weak rib-like thickenings are indicated on the ventral surface of capsule walls. A terminal lappet has not been observed in any of the specimens, but in one of the specimens a pair of very small anchors could be traced at the region of the posterior end of the body between the last pair of clamps where a terminal lappet with anchors is usually indicated in plectanocotylid worms. This indication is however, not observed in the other two specimens though this area is stained darker than the rest.

Mouth subterminal slit-like, without preoral glands; oral pouches large oval, similar, 90×60 μ; pharynx small, oval, 60×40 μ, wedged in between the oral pouches; oesophagus narrow and unbranched, bifurcates into the crura at about ⅛ the total length from the anterior end of the body; crura with many lateral outer branches and few short inner branches and confluent posteriorly at the base of the haptor with short branches to each clamp peduncle.

Testes numerous, irregular in shape, all post-ovarian, intercrural terminating at the base of the haptor bordered by the intestinal confluence; seminal vesicle elongate oval and situated at the anterior lateral region of the testes zone; vas deferens long median and narrow opening into the male genital pore placed at the intestinal bifurcation. The male pore is armed with 10 conical recurved spines pointing into the median pore which is 0·34 mm from the anterior end of the worm and placed at the centre of a disc-like area of 0·05 mm in diameter. An elaborately armed male intromittent organ is not observed in this species.

Ovary intercrural, inverted U-shaped and situated in the second fifth of the body between the left intestinal crus and the median vitelline duct; oviduct short and narrow, connecting the distal end of the ovary with the ootype. Ootype median oval and situated posteriorly near the distal ovary and median vitelline duct. A genito-intestinal canal is present connecting the ootype and the right intestinal crus.

Vitellaria small and scattered around the crura and branches, from the level of intestinal bifurcation to the base of the haptor and confluent posteriorly along with the intestinal confluence. Transverse vitelline ducts short and broad, joins at the anterior level of the ovary to form the median vitelline duct which is long and broad narrowing posteriorly parallel to ovary to empty into the ootype. A vaginal duct or vaginal pore is not observed.

DISCUSSION

The new monogenetic trematode has many of the family characters of Plectanocotylidae, Poche 1925, especially an elongate symmetrical body and haptor with four pairs of pedunculate clamps, male terminalia armed with a cluster of conical curved spines, U-shaped ovary with limbs directed backwards, numerous postovarian testes, absence of vagina and presence of a genito-intestinal canal. However, there are many important characters showing marked differences from the family: the clamps though basically plectanocotylid, the jaw moities are continuous medially and articulated with the expanded extremities of the U-shaped median spring. The jaw sclerites are not jointed. The median spring is broad and complete with corrugated outer margin, and there is a convex additional piece of sclerite on the axial half of the clamp which is different from the oblique sclerite of gastrocotylid worms. A terminal anchored lappet is not observed. The male terminalia though armed is simple with a cluster of spines and not with a sheaf of long slender spines forming a cirrus. The pattern of sclerites in the clamps and the structure of the male terminalia makes this species very different from the typical plectanocotylid worm where the development of these organs are on different footing than the present species. The sclerite pattern shows the species to be more close to Mazocraeidae, Price, 1936, but the cuticularisation is of a higher grade and the sclerites are more advanced in structure. The male terminalia is of a very simple pattern forming a cluster of recurved spines more like those of diclidophorid worms. The general shape of the body, distribution of clamps and gonads, and the structure of the male terminalia provides the present species a position in family Diclidophoridae, Fuhrmann, 1928. The clamp structure, especially the broad cuticularised sclerites, shows close resemblance to those of diclidophorid worms. The closest resemblance is shown to *Upenicola upeneoides*, Unnithan, 1966, especially in the haptor, clamps and male terminalia, but it cannot be accommodated in the genus *Upenicola* due to the higher stage of development exhibited in these essential organ systems. Hence the present species is given the new generic status and accommodated in family Diclidophoridae occupying a position between *Upenicola*, Unnithan, 1966 and *Diclidophora*, Diesing, 1850.

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October 22, 1967.

R. V. UNNITHAN

27. NOTE ON A SIMPLE DEVICE FOR THE RAPID SORTING OF BENTHIC SAMPLES

(*With two text-figures*)

INTRODUCTION

The problem of washing and sorting bottom samples obtained by dredging has long been felt by various workers. Fedikov (1960) devised a simple method for the washing of bottom samples that has been used extensively by U.S.S.R. Research Vessels, participating in the International Indian Ocean Expedition. A similar device was used by us in our cruises in the Indian Ocean. Although this device (Fedikov's) was fairly effective, certain improvements introduced by us resulted in higher sorting efficiencies in much shorter times. This modified device is described in detail in this note.

Description :

The modified device consists of a cylindrical galvanized steel vessel, 90 cm long with an inside diameter of 60 cm. Inside the cylinder a spirally coiled tube of 2 cm diameter extends from the base to the apex as shown in figure 1. The upper surface of the coiled tube is provided with fine holes of 2 mm diameter spaced 1 cm apart so that when sea-water is pumped into the tube through the inlet pipe, A, jets of water gush out with force. The outlet pipe at B lets out the remaining water, which is collected at the base of the cylinder and flows out through the tap C. At the top of the cylinder, 4 sieves of different meshes are placed one above the other, the smallest-meshed sieve being the lowermost and the widest-meshed the uppermost. The topmost sieve is reinforced with expanded-metal base. The cylinder is closed by a lid L, at the lower surface of which is fixed a coiled tube with inlet and outlet pipes D and E (Fig. 2). In this tube also there are minute holes spaced 1 cm apart but on the lower side so that when water is pumped into the pipe inlet D and let out through the outlet E, jets of water are directed downward with force.

Sorting Procedure :

The procedure used in cleaning and washing the bottom samples is as follows :—

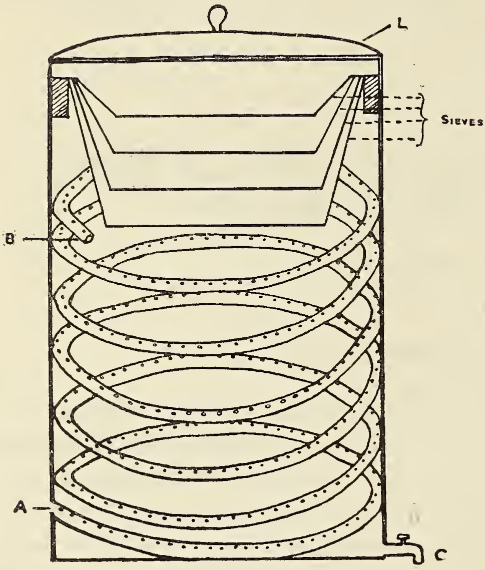

FIG. 1

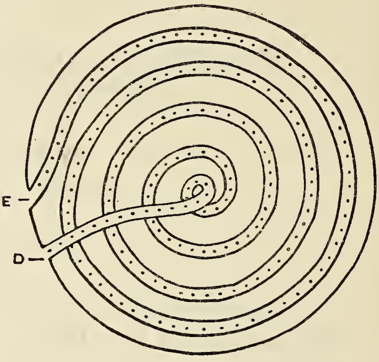

FIG. 2

The bottom samples collected from the dredges are placed in the uppermost sieve and then closed with the lid. Sea-water is now pumped simultaneously into the tubes in the cylinder as well as in the lid through the pipes A and D. The water gushes out both upwards and downwards with force from the tubes in the cylinder and lid respectively, washing the samples placed in the uppermost sieve. After a few minutes the sample gets separated and settles down according to size in the different sieves from where they are collected. To ensure the collection of microfauna, the lowermost sieve should have an average aperture size of 0·064 mm, made of standard grade Dufour bolting-silk No. 25 (200 meshes per inch).

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA-16,
August 13, 1969.

A. DANIEL
V. K. PREMKUMAR

REFERENCE

FEDIKOV, N. F. (1960) : Device for washing bottom fauna samples. Publication from the Institute of Oceanology, Moscow (In Russian).

28. ON THE OCCURRENCE OF *LUDWIGIA HYSSOPIFOLIA* (G. DON) EXELL (ONAGRACEAE) IN WESTERN INDIA

Ludwigia hyssopifolia (G. Don) Exell— a pan-tropical weed of probably African origin, now widespread in Kerala, Orissa, W. Bengal, Assam and Bihar in India, is recorded here for the first time from Bombay, Western India.

L. hyssopifolia (G. Don) Exell is closely allied to and, in fact misidentified in the past in Indian herbaria with *L. prostrata* Roxb., but is easily recognisable by stamens being twice the number of petals and capsule with multi-seriate seeds at the top and uniseriate seeds in the lower part. It can be readily distinguished from the rest of the Indian species of the genus *Ludwigia* Linn. by its characteristic capsule having pluriseriate seeds in the upper inflated part and uniseriate seeds in the lower part and dimorphic seeds.

The presently accepted nomenclature of this interesting taxon is as follows :

Ludwigia hyssopifolia (G. Don) Exell, Garcia de orta 5 : 471, 1957 ; Raven in Reinwardtia 6 : 385, 1963 ; Sreemadhavan in Bull. Bot. Surv. Ind. 8 : 79, 1966.—*Jussiaea hyssopifolia* G. Don, Gen. Syst. 2 : 693, 1832.—*J. linifolia* Vahl, Eclog. Amer. 2 : 32, 1798 (non *Ludwigia linifolia* Poir, 1813).—*J. micrantha* Kunze in Linnaea 24 : 177, 1851.—*J. fissendocarpa* Haines in Journ. Asiat. Soc. Beng. N.S. 15 : 313, 1920; et Bot. Bih. & Oris. 382, 1922.—*Ludwigia micrantha* (Kunze) Hara in Journ. Jap. Bot. 28 : 293, 1953.—*Fissendocarpa linifolia* (Vahl) Bennet in J. Bombay nat. Hist. Soc. 67 : 125, 1970.

Specimens examined : MAHARASHTRA : Bombay, Trombay, Sept. 25, 1969, *C. R. Babu* 1 (CAL) : Common weed of waste places and roadsides. Flowers : yellow. BIHAR : Ranchi, Oct. 15, 1967, *R. N. Banerjee* 130 (CAL) : In a cool, moist, shady slope.

CENTRAL NATIONAL HERBARIUM, C. R. BABU[1]
HOWRAH-3,
June 3, 1971.

29. OCCURRENCE OF *COCHLEARIA COCHLEARIOIDES* (ROTH) SANT. & MAH. & *CAMPANULA BENTHAMII* WALL. EX KITAMURA IN GUJARAT STATE, INDIA

During the course of botanical exploration of the Kawant Range forest, Chhotaudepur division, Gujarat state, the authors collected two interesting plants, which are new to Gujarat. They are described along with observation on their habits.

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[1] Present address : Department of Botany, University of Delhi, Delhi-7, India.

Cochlearia cochlearioides (Roth) Sant. & Mah. (=*Cochlearia flava* Buch.-Ham.) is an erect, glabrous, diffusely branched, annual herb, about 30 cm high. Leaves pinnatifid, lobes sinuate-toothed; lower leaves long-petioled and the upper short-petioled to almost sessile. Flowers small, yellow in elongate racemes. Silicula glabrous, hemispheric with membranous valves. Seeds small, numerous, rugose; funicles filiform.

A small population of these plants was noted on an undisturbed portion of the Narmada River bank at Hampheshwar. The plants have a restricted distribution and are not to be met with in any other part of the area (DNT 1555, Dated 31.1.71).

The plant is distributed in certain parts of upper and lower Gangetic valleys, west Bihar and central Bengal. As far as the authors are aware, the plant has not been mentioned in any work on the flora of Gujarat and possibly also of the erstwhile Bombay Presidency.

Campanula benthamii Wall. ex Kitamura (=*C. canescens* Wall. ex DC.) is an erect, hairy, sparingly branched herb, 10-60 cm high with a crowded basal rosette of leaves. Branches when present arising below the rosette leaves. Stems hirsute. Leaves lanceolate, crenate, sparsely hairy. Flowers in axillary and terminal panicles. Flowers protandrous, young flowers purple-blue in colour and show mature anthers and small styles with 3, closed, stigmatic lobes. Older flowers fade and become white or dirty white, which show empty anthers and well-developed styles with 3, recurved, stigmatic lobes. Cream-coloured flowers with purple tips form an intermediate stage. Corolla companulate, hairy on the back, Stamens 5, filaments dilated. Ovary tricarpellary, placentation axile; placenta triangular, peltate; ovules numerous. Capsules subglobose, 3-celled with numerous compressed seeds.

Imperfect flowers mentioned in the earlier descriptions have not been met with.

In our locality, the plants have been found to be restricted to steep escarpments of the banks of River Banganga from Kadipani to Hampheshwar (DNT 1469, 28.1.71). They were noted growing along with *Blumea* sp., *Cyathocline purpurea* (Don) Kuntze, and *Hemigraphis latebrosa* var. *heyneana* Brem.

The plant is not mentioned in the Cooke's flora of the Presidency of Bombay. However, it has been collected by Blatter from Panchgani, Bell from Ambavadi in north Konkan and Santapau from Purandhar. At Purandhar it was nowhere abundant but was spread all over the hill, in gardens and along the paths in December.

Although widespread in its distribution from Himalayas to central India, the plant has not been collected so far from any locality in Gujarat state.

This study has been financed in part by a grant made by the United States Department of Agriculture under PL-480.

Taxonomy Laboratory,
Department of Botany,
The M. S. University of Baroda,
Baroda,
April 24, 1971.

D. N. THAKER
S. D. SABNIS

30. TWO NEW PLANT RECORDS FOR INDIA FROM KASHMIR

(*With two plates*)

During a survey of the weeds of Kashmir, I came across the following two species in cultivated fields at Barzulla, Srinagar. The species are not recorded in the existing floristic records in India. Specimens have been deposited at the herbarium of Royal Botanical Gardens, Kew, and at the Blatter Herbarium, Bombay. *Phacelia tanacetifolia* Benth. (Hydrophyllaceae) occurs in the campus of the Regional Research Laboratory, Srinagar, among the experimental pyrethrum plants. It thrives well in its new location. It was perhaps introduced inadvertently with seeds from California, USA. *Sideritis montana* Linn. (Labiatae) occurs on fallow lands at Rawalpora and in some orchards at Barzulla in Srinagar. This species is noted as a weed in Europe and is a recent introduction in Kashmir.

Since the two weeds are not described in any of the Indian floras, their description and diagrams based on specimens collected from Srinagar are given.

Phacelia tanacetifolia Benth. in Trans Linn. Soc. 17 : 280, 1837. Munz & Keck in Fl. California, 529-530, 1959.

Annual herb. Stem up to 75 cm, erect, somewhat woody towards the base, branched, slightly greenish purple, grooved, silky pubescent especially towards the apices of the branches. Leaves 9-19·5 cm long, 2-pinnatisect, lobes up to 5 mm long, ovate-lanceolate ; alternate, exstipulate, lower petiolate ; petiole 1·0-2·5 cm long, pulvinate, slightly silky pubescent ; upper sessile, rachis more pubescent. Flowers in long scorpioid, compact cymes, initially looking like small heads, 25-40 in each cyme ; ebracteate, subsessile to sessile, peduncle hairy. Sepals 5, ·3-·7 cm long, linear to obovate, acute, sparsely hairy ; hairs white ; green, persistent. Petals 5, up to 1 cm long, united at the base but free above the middle, broadly campanulate, lobes ovate, purplish, distinctly veined. Stamens 5, filaments filiform, as long as the styles of the ovary, glabrous, arising from the base of the corolla tube; anthers globular, dorsifixed, dehiscing early. Ovary on a hairy receptacle, superior, slightly pubescent, pointed towards the apex, 2-celled with 1-2 ovules in each cell. Styles 2, up to 1·3 cm long, hairy up to the middle divergent, saffron-coloured. Seeds usually 2, grayish-brown.

Indigenous in California, U.S.A.

Specimen examined: Kaul 26(1.5.69) Barzulla Lab. campus. (see Plate 1).

Sideritis montana Linn. sp. Pl. 575, 1753. Polunin in Fls. Europ. 351(t.6), 1969.

Annual herb. Stem up to 20 cm, erect, branched from the base, angular, woolly all over, jointed, leaves, 1·5-4·0 cm × ·3-·8 cm, simple, opposite, oblong-lanceolate, sessile, hairy all over, more on the margins; lower leaves blunt and upper mucronate. Flowers bracteate; bracts leafy, longer than the flowers, in verticles on long, lax and leafy spikes, each whorl usually six-flowered. Calyx gamosepalous, cupular with five spiny-tipped lobes, three upper forming the upper lip; tube up to ·8 cm, somewhat longer than the lobes, base swollen, distinctly ribbed, hairy. Corolla gamopetalous, bilipped, generally as long as the calyx or slightly exerted, yellowish with brown dots, turning brown on maturity. Corolla tube up to 4 mm. long, hairy outside. Upper lip with three conspicuous lobes, hairy and lower lip with two small lobes, dotted. Stamens 4, included in the corolla tube, didynamous, anthers small, globular. Ovary on a raised, rectangular and glabrous receptacle. Style included in the corolla tube, gynobasic. Capsule with 4-nutlets, each nutlet 2-4 mm diam., tapering towards the apex with a definite median ridge, mottled, slightly brownish.

Distribution: Europe.

Specimen examined: Kaul 11(3.12.68) Barzulla
Kaul 25 (21.4.69) Rawalpora (see Plate 2)

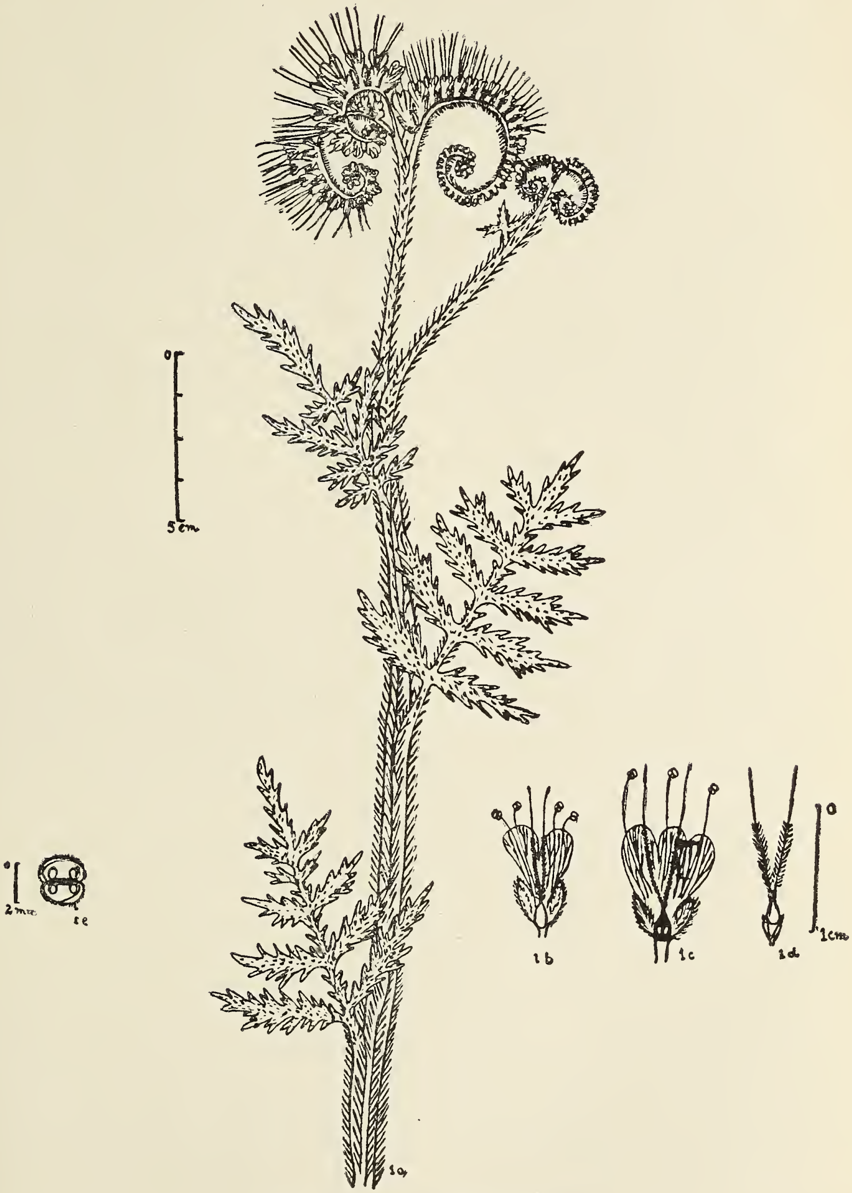
ACKNOWLEDGEMENTS

Special thanks are due to the Director, Royal Botanical Gardens, Kew, for confirming the identification of these plants, to Dr. S. N. Sobti for his help during the preliminary identification and to the Director, Regional Research Laboratory, Jammu, for providing facilities. The author is indebted to Prof. P. V. Bole of St. Xavier's College, Bombay, for his criticism and comments.

REGIONAL RESEARCH LABORATORY,
SANAT NAGAR, SRINAGAR-5,
INDIA,
April 19, 1971.

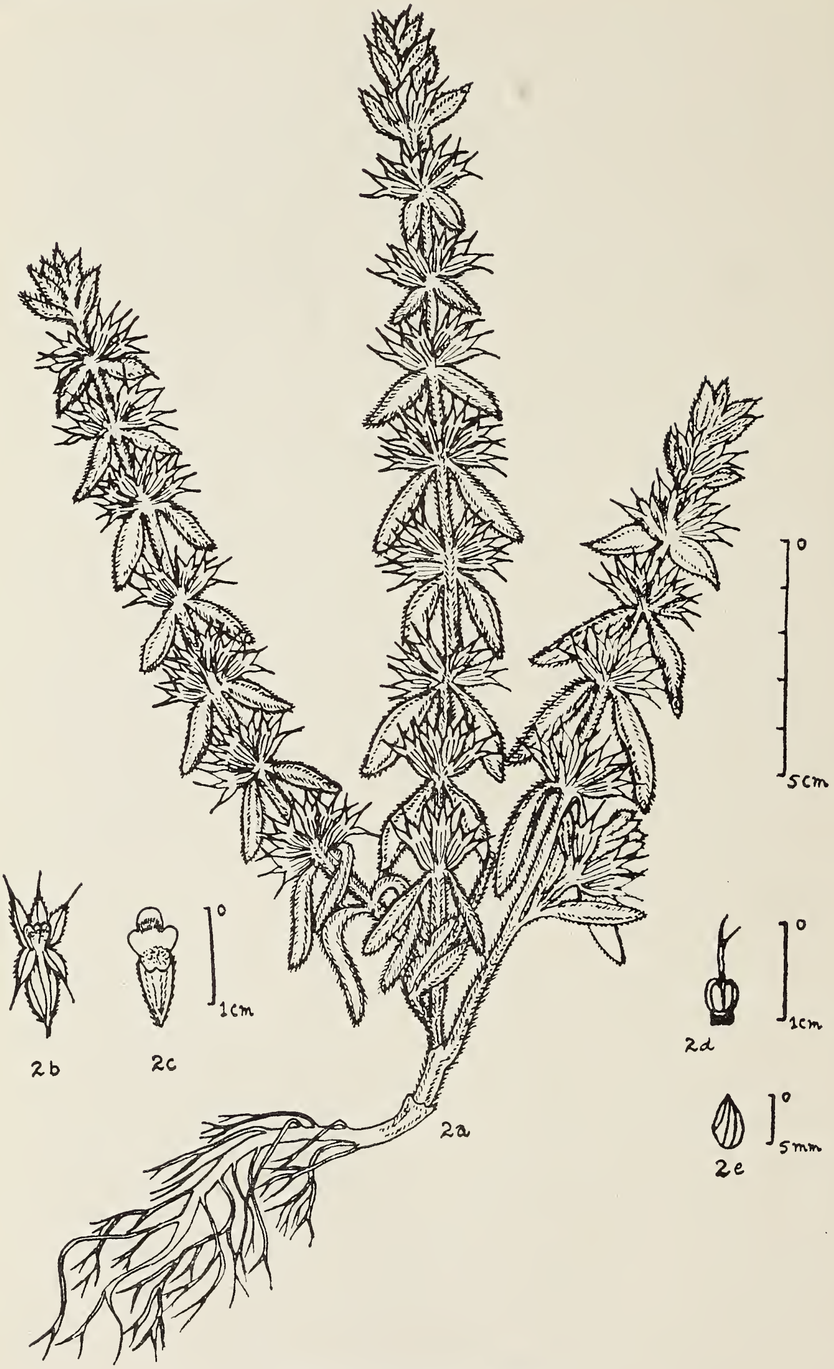
M. K. KAUL

Kaul: New plant records


0
5 cm
2 mm
1e
1b
1c
1d
0
1 cm
1a

Phacelia tanacetifolia Benth.

a. A flowering branch ; b. A flower ; c. V.S. flower ; d. Ovary ; e. T.S. Ovary.


0
5cm
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Sideritis montana Linn.

a. A flowering plant; b. flower; c. Corolla tube with lobes; d. Ovary; e. nutlet.

31. FAMILY ERIOCAULACEAE IN KOLHAPUR AND ITS ENVIRONS

As a part of their studies on the revision of the flowering plant families of Kolhapur and its environs, an account of Commelinaceae was given by Kulkarni & Mudgal (1970). This note is in continuation of the series and deals with the family Eriocaulaceae of the region.

The identification of the species listed here is based upon the study of several fresh collections made from different localities of this region. The nomenclatural changes of the taxa identified were confirmed by consulting H. N. Moldenke of U.S.A. The herbarium specimens are deposited in the herbarium of Shivaji University, Botany Department, Kolhapur.

Key to the species of *Eriocaulon* from Kolhapur

- *Plants of running water ; stem well developed*
  - Leaves 3-4 mm wide ; involucre black........................*E. breviscapum*
  - Leaves less than 2·5 mm wide ; involucre pale......................*E. dalzellii*

- *Plants terrestrial or of marshes ; stem very short or absent*
  - Sepals crested
    - Female sepals alone crested
      - Bracts stellately spreading..................................*E. stellulatum*
      - Bracts not stellately spreading
        - All the female sepals equally crested..................*E. margaretae*
        - Crest well developed on only two female sepals................*E. elenorae*
    - Both male and female sepals crested
      - Leaf apex rounded and cuspidate ; involucral bracts glabrous....*E. cuspidatum*
      - Leaf apex obtusely acuminate ; involucral bracts dorsally white powdery pubescent..*E. vanheurckii*
  - Sepals noncrested
    - Involucral bracts projecting above the head
      - Petals glandular......................................*E. xeranthemum*
      - Petals eglandular
        - Third female sepal oblanceolate, flat, equalling the others in size.... ....*E. dianae*
        - Third female sepal linear, smaller than the others.................. ....*E. dianae* var. *longibracteatum*
    - Involucral bracts not projecting above the head
      - Anthers white or yellow
        - Female petals absent, sepals reduced to bunch of hairs......*E. cinereum*
        - Female sepals and petals both present..................*E. ritchieanum*
      - Anthers white when young but becoming blackish at maturity ; plants tuberiferous...*Eriocaulon* sp.
      - Anthers black
        - Male and female sepals two
          - Female petals absent......................................*E. achiton*
          - Female petals present
            - Involucral bracts glabrous...............................*E. duthiei*

Involucral bracts densely covered with white hairs........*E. sedgwickii*
Male and female sepals three
One male petal larger and extruded beyond its floral bract...........
....*E. polycephalum*
Male petals equal or subequal, none extruded beyond the floral bract
Leaves turning red on drying...................*E. quinquangulare*
Leaves not turning red on drying
Heads truncated by the very horizontal involucre, pollen-grains pantoporate...*E. truncatum*

Heads not truncated ; pollen-grains spiraperaturate
Female sepals with dense tuft of hairs on the back towards apex...........
....*E. wightianum*
Female sepals glabrescent
Heads conical...*E. conicum*
Heads globose
receptacle glabrous....................................*E. nepalense*
receptacle villous.......................................*E. collinum*

The family is represented by 23 taxa belonging to the genus *Eriocaulon.* They fall into five out of eight sections by Fyson (1919) of this genus. The numbers given in brackets refer to herbarium specimens deposited in the University herbarium.

Section SIMPLICES (a)

E. nepalense Prescott. Abundant in paddy fields of Kolhapur (315) and Panhala (530) during monsoon. August-September.

E. truncatum Hamilt. Grows on moist rocky soils and in paddy fields along sea shore of Vengurla (1002). October-November.

E. duthiei Hook. f. Pretty common in marshes near Lingamala, Mahabaleshwar (1011). September-October.

E. xeranthemum Mart. Grows on moist soil and in paddy fields. Radhanagari (730), Amboli (901) and Savantwadi (1005). September-November.

SIMPLICES (b)

E. quinquangulare L. Common along the margins of puddles and in marshes. Amba (850). December-January.

E. dianae Fyson. Most common member of the marshes of Kolhapur (316), Kagal lake (317) and Radhanagari (731). August-September.

E. dianae var. **longibracteatum** Fyson. Moist soils of Kolhapur (318) ; often grows in association with *E. dianae.* August-September.

E. conicum (Fyson) Fischer. On the surface of moist rocks. Kolhapur (319) and Panhala (531). August-September.

E. collinum Hook. f. Marshes of Kolhapur (320), Kagal lake (321) and Vadanige lake (322). September-October.

E. achiton Korn. Grows on moist lateritic soils. Panhala (532), Radhanagari (732) and Amboli (909). August-September.

E. sedgwickii Fyson. Most common in grass lands near Gaganbavada (686, 687). August-September.

HIRSUTAE

E. wightianum Mart. An elegant species ; very common in muddy soils and along streams. Often grows intermixed with *E. stellulatum*. Radhanagari (733-735), Amboli (902-904) and Bilashi (741). September-October.

ANISOPETALAE

E. polycephalum Hook. f. (*E. longicuspis* var. *polycephalum* Fyson). Along the margins of puddles mixed with *E. cuspidatum* on the way to Dhamapur from Malvan (1010). August-September.

CRISTATO-SEPALAE

E. margaretae Fyson. Along sandy beds of the lake at Panhala (534). Common in moist and marshy localities of Kolhapur (323), Panhala (533) and Radhanagari (736). August-September.

E. elenorae Fyson. Grows in moist lateritic soils of Panhala (535), Radhanagari (737) and Amboli (1000). September-October.

E. stellulatum Korn. In marshy areas and along the streams. Radhanagari (738), Amboli (905) and Bilashi (742). September-October.

E. cuspidatum Dalz. In moist forest soils at Anandvahal (1011) ; along the margins of puddles on the way to Dhamapur (1013) ; most common in rice fields at Malvan (1014). September-October.

E. vanheurckii Muell-Arg. On moist rocks along the streams. Amboli (907). September-October.

LEUCANTHERAE

E. cinereum R. Br. (*E. sieboldianum* Sieb. and Zucc.) Common on moist rocks and lateritic soils in Panhala (536) and Phonda ghats (740). September-October.

E. ritchieanum Ruhl. Grows intermixed with *Isoetes* spp. in muddy soil along the margins of the pond in Panchgani (1010). September-October.

E. breviscapum Korn. In and along the streams at Anmod (1019). January-April.

E. dalzellii Korn. (*E. rivulare* Dalz.) In running water at Amboli (908) and Pali (56). September-October.

Eriocaulon sp. Tuberiferous species in muddy places along the margins of puddles often in association with *Isoetes* spp. Panhala (537) and Radhanagari (739). July-September.

Though *E. margaretae* is described to have glabrous receptacles by Fyson (1921), the populations of this species collected from Panhala and Radhanagari have distinctly villous receptacles whereas those collected from Kolhapur have glabrous receptacles. It appears that the development of indumentum which is often taken to be a sectional or subsectional character in the classification of this genus is markedly affected by environmental factors as suggested by Fischer (1928).

A population of *E. stellulatum* collected from Amboli differed from rest of the collections of this species in its diminutive habit and in the foliar epidermis which had wider cells with conspicuously wavy walls. These differences do not appear to be ecological since the plants belonging to *E. stellulatum* proper were found growing mixed-up with the plants of this variant in the same habitat at Amboli. Further studies on the taxonomic status of this variant with respect to *E. stellulatum* proper are in progress.

The detailed examination of the herbarium specimens of *E. ritchieanum* represented in different regional herbaria of Botanical survey of India suggest that the tuberiferous plants formerly described by the authors (1970) as belonging to *E. ritchieanum*, appear to be distinct from this species in some of their floral features also. Hence for the time being they have been listed separately here.

In the genus *Eriocaulon* each scape as a rule bears a single terminal head. During the present study tendency to form branched heads was noticed in *E. margaretae*, *E. dalzellii* and *E. cuspidatum*. In the former two species branching was observed as a rare phenomenon whereas the population of *E. cuspidatum* collected from Anandvahal near Malvan showed maximum frequency of branching. In this species several peduncles of each plant were found to end in a bunch of 3-5 umbellately arranged heads instead of a single one.

Development of tetra- and hexacarpellate gynoecia was noticed in a few plants of *E. margaretae* and *E. conicum* respectively. These observations are interesting since the occurrence of more than 3 carpels in a gynoecium is unknown in this entire family.

ACKNOWLEDGEMENT

The authors are indebted to Dr. H. N. Moldenke of U.S.A. for critically going through the notes and herbarium specimens sent to him. They are also thankful to the authorities of the Botanical Survey of India, Southern, Western and Central herbaria, for lending specimens of *E. ritchieanum* for comparison.

BOTANY DEPARTMENT,
SHIVAJI UNIVERSITY,
KOLHAPUR,
May 5, 1971.

A. R. KULKARNI
M. H. DESAI

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FYSON, P. F. (1921): Indian species of *Eriocaulon.* ibid. **2**: 307-320.

KULKARNI, A. R. & DESAI, M. H. (1970): Tubers in *Eriocaulon ritchieanum* Ruhl. *J. Bombay nat. Hist. Soc.* **67**: 134-135.

32. DISTRIBUTION OF *GELIDIELLA ACEROSA* (FORSKÅL) FELDMANN & HAMEL

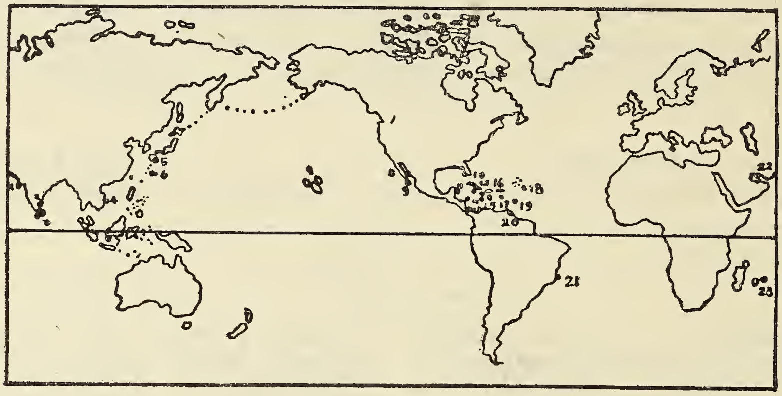
(*With a map*)

Among the four species of *Gelidiella* reported from Indian coasts, *G. myrioclada* Boergs and *Gelidiella* sp. are endemic, and *Gelidiella bornetii* is limited in distribution to India and Kei islands. Hence, *Gelidiella acerosa* (Forskål) Feldmann et Hamel, which is a widely distributed species, is considered here to understand its distributional pattern in the world.

During the monographic treatment of *Gelidiella acerosa*, available along the west coast of India and south-east coast of Madras, the author had an opportunity to study the various available species of this genus in the world deposited in the herbarium collections maintained at Madras University, Madras. Based on the study of these herbarium specimens, an attempt is made to know the extent to which the distribution of *Gelidiella acerosa* agrees with the previously recognised marine algal provinces (Fritsch 1945; Silva 1957).

It can be seen from the map that this alga spans the equator and is represented in the three oceans—Indian, Pacific and Atlantic.

In the Indian ocean, its north-western limit is in the Red sea and Iranian Gulf (Boergesen 1939), while in the west it has been reported only from Mauritius (Boergesen 1950). In the north, it occurs along the northern part of the Arabian sea and in the south in Ceylon and south India.



In the Pacific Ocean, its occurrence in the southern part of Kyushu (Japan) is noteworthy. Okamura (1926) states that a considerable number of seaweeds present along the southern shores of the Japanese islands belong to the Indo-Pacific region, while, comparatively few appear to occur on the American Pacific shores. However, *G. acerosa* is known also from the Gulf of California (Dawson 1944). It is interesting to note its absence in the Australian flora with which the Indian flora has been shown to have considerable similarity (Boergesen 1934).

In the Atlantic ocean it is well represented in the western tropical Atlantic coasts, while it is absent from the west African coasts on the eastern part of the Atlantic. Boergesen (1915-20) has shown that several seaweeds known from Indo-Pacific region and West Indies are generally absent from the southern extremities of Africa and America.

The distribution of *Gelidiella acerosa* in the Indian and Pacific ocean supports the occurrence of Indo-Pacific algal province, whose existence has been recognised by many workers.

On the basis of the distribution of the tropical marine algae in the Indo-Pacific region and West Indies, it was considered that these migrated to the Atlantic (Fritsch 1945). As our knowledge of distribution of marine algae is limited, it is difficult to know the original home of any particular species. However, on the basis of the distributional pattern of *Gelidiella acerosa* it appears that this alga was originally from the Atlantic.

ACKNOWLEDGEMENTS

The author is thankful to Dr. C. S. Prakasa Rao of Banaras Hindu University, Varanasi, for the guidance provided during the course of the

present study and to Dr. D. S. Datar of Central Salt & Marine Chemicals Research Institute, Bhavnagar, for the facilities provided. Thanks also are due to Prof. T. V. Desikachary for the kind permission accorded to the author to study the herbaria at Madras University.

CENTRAL SALT AND MARINE CHEMICALS RESEARCH INSTITUTE,
BHAVNAGAR,
April 12, 1971.

P. SREENIVASA RAO

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33. RECORD OF *DRAPARNALDIA ACUTA* KUTZ. FROM GUJARAT

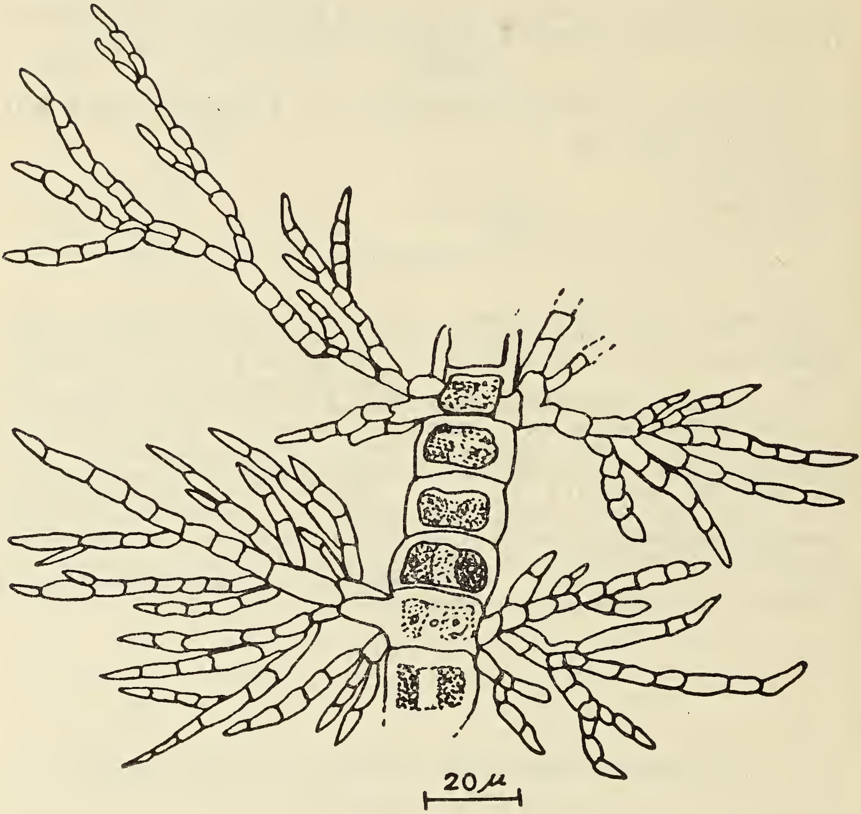
(*With a text-figure*)

The only record of *Draparnaldia* from India is that of Randhawa (1936). He reported *D. plumosa* from 'N. India'. Srinivasan (1965) has made no mention of the genus in his work. During the course of investigation of algal flora of the region *Draparnaldia acuta* Kutz. has been reported from Ahmedabad and for the first time from the country. The alga is briefly described below. The description conforms with that given by Prescott (1951).

Main axis of the thallus bearing horizontal whorled fascicles of branchlets which are ovate to acuminate in outline; cells of the main axis and branchlets are slightly swollen, 34-36 μ in diameter; cells of the branchlets 8 μ in diameter. Chloroplast $\frac{1}{2}$ the length of the cells.

Found in the swamp behind the University, Ahmedabad, on 16th July, 1970.

The main characteristic of the species is the lateral branches forming a broad spreading fascicle. The branchlets are acute and main axis of the fascicle does not retain its identity.



Botany Department,
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Ahmedabad-9,
May 17, 1971.

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34. ON THE GERMINATION OF COCOA SEEDS

(*With a photograph*)

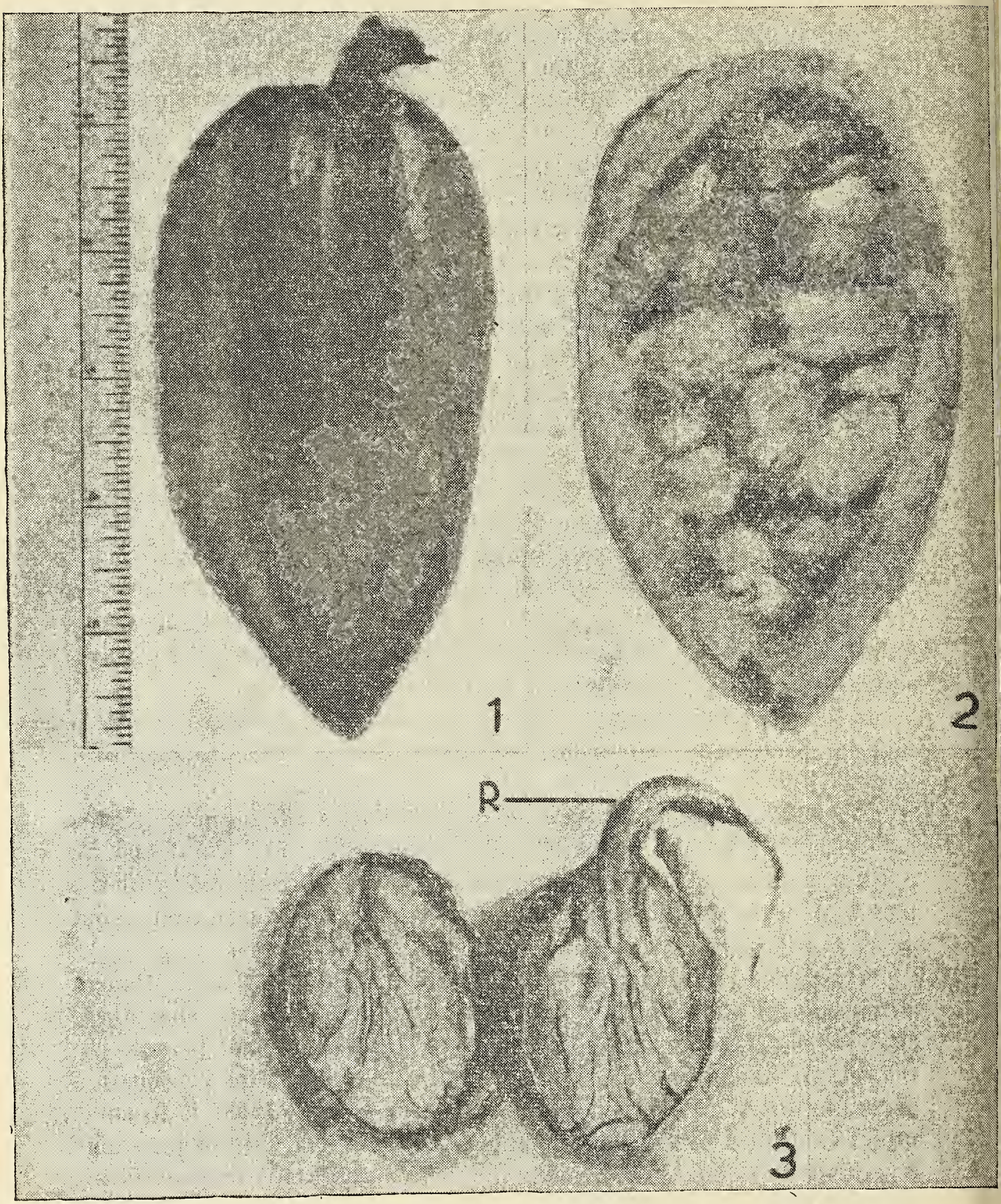
The Institute of Science garden has probably the only Cocoa (*Theobroma cacao*) plant in the city of Bombay. It has been bearing flowers during the last 9-10 years, and the number of flowers produced has showed a steady increase year after year. Up to the 1967-68 flowering season, there was no fruit-bearing in spite of abundant flowering. In the year 1969-70, about 100 fruits, 5-8 cm in length were observed on the plant. After a few days these changed colour from yellow to red and later all of them shrivelled, became black, and dropped. There were no signs of any embryo within them. Wright (1907) in his monograph on Cocoa, as quoted by E. E. Chessman (1927), states that these cases may be regarded as cases of succulence without fertilization.

According to Arne Muntzing (1947) ' self-incompatible trees show a very profuse flowering but evidently only a small fraction of these flowers gave rise to fruits. In Cocoa this wilting of fruits seems to be a normal physiological phenomenon caused by the limited ability of the tree to bear fruits '. It is interesting to quote Arthur Hakansson (1947), who states that a cocoa tree under his observation produced about 50,000 flowers, the number of fruits set was 6000 and only 100 mature fruits were obtained. Brink and Cooper (1941), in their work on certain hybrids, as quoted by Hakansson (op. cit.), state that this kind of sterility should be called as somatoplastic sterility.

In the flowering season of 1969-70, the plant had produced hundreds of flowers and many fruits out of which only 9 had reached the size shown in fig. 1. On breaking open all, only two showed germinated seeds inside (Fig. 2). The number of seeds in various stages of germination was nearly half the total number of seeds inside each fruit. On dissecting out it was found that these germinated seeds have no connection with the parent plant tissues and radicles of varying lengths were seen coming out of the mucilaginous coating of each seed (Figs. 2 & 3).

As suggested by Khan (1945) this type of germination of seeds, though still inside the fruit, could be classified as spurious vivipary, since these seeds do not take any nourishment from the parent plant tissues. In the case of mangrove seeds, which exhibit true vivipary, the germination according to A. M. Mayer and A. Poljakoff-Mayer (1963), is to some extent controlled by the salt contents of the fruit, and this vivipary may be regarded as a means of evading the unfavourable environment during germination.

Singh & Lal (1937) have found that viviparous varieties of mango showed splitting of the endocarp at the broader end. This split endocarp was found to favour germination and thus it might account for the phenomenon of vivipary in mango. Kelkar & Navalkar (1958) have shown spurious vivipary in *Erythrina indica* where it is found that the curved and splitted halves of the legume, provide a suitable place for germination during favourable climatic conditions. No such split was observed in the fruits of Cocoa.



What exactly causes the germination of seeds without having any dormant period, within a fruit, is summarized by A. M. Mayer and A. Poljakoff-Mayer in their book THE GERMINATION OF SEEDS: 'Many extracts from fruits and seeds have shown that they contain mixture of substances, some of which inhibit, while others stimulate germination, while yet others are active in affecting growth. The amount of these substances changes with time and with treatment of the seeds. It seems likely that germination is not simply controlled by inhibitors but that the interaction of both promoting and inhibitory substances regulate it'.

No independent plants could be grown from these germinated seeds. What stops this activity is not clear. The material shown in Fig. 2 is kept in the Institute of Science Botanical Museum.

ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to Dr. B. C. Haldar, Director, Institute of Science, Bombay, for encouragement, Dr. S. David, Botany Dept., University of Poona, for valuable help and to Shri A. M. Siddiki, for photographing the material.

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35. SEASONAL VARIATION IN CHEMICAL CONSTITUENTS OF SOME AQUATIC PLANTS[1]

The dependence of aquatic plants on the substratum for nutrients has been a matter of controversy though Pearsall (1920) and Misra (1938) propounded the absorption of nutrients by aquatics from the substratum. According to Welch (1935) the substratum provides only mechanical support and the aquatic plants derive nutrients from the surrounding water. The chemical analysis of a few aquatic plants were undertaken in order to understand the variation of chemical constituents during different stages of growth, flowering and fruiting. The water in which these plants were growing was also analysed periodically for its relationships to the aquatic plants.

Material and Methods

The samples of aquatic plants included roots, flowers, and fruits and care was taken to collect plants of the same age from different parts of the Doodhadhari Lake. No attempt was made to separate out plants from different depths.

The dry ashing technique was used throughout as recommended by Peach & Tracy (1956). Five grams of oven dry sample was taken in a Silica basin and the ash digested in hydrochloric acid was made to 250 ml in a volumetric flask. The residue is reported as silica and the solution was used for the determination of different elements.

The Kjeldahl method as recommended by Jackson (1958) was used for determination of total nitrogen, from 0·5 gm. of dried plant material.

The hydrochloric acid extract was used for the determination of calcium by titrimetry, magnesium by gravimetry and sodium and potassium separate by flame photometric methods.

Observations

Calcium : The concentration of calcium was found to show two peaks in most of the plants. Some plants showed a third peak also. The first peak was found in late rainy season and this continued till February. From February onwards a decline was found up to April. From April the concentration increased except in *Eichhornia*

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[1] Based on a part of the Thesis submitted for the Degree of Ph.D. to the R.S. University, Raipur.

crassipes and *Najas minor.* The fluctuation of calcium was found more or less related to the growth periods. In September most of the plants were mature and showed maximum calcium. In February regeneration of plants probably brought about a decline in calcium.

Magnesium : *Eichhornia crassipes, Pistia stratiotes* and *Ceratophyllum demersum* recorded maximum magnesium content in February. Except for *Hydrilla* a general decline in magnesium was recorded. Regeneration after February brings forth this decline as large amounts of magnesium are withdrawn for photosynthesis and other metabolic processes. Young shoots of *Najas* and *Trapa* were found to contain very little of magnesium as observed from February to July. *Trapa bispinosa*, and *Pistia stratiotes* showed maximum in September.

Potassium : *Eichhornia* and *Pistia* were found to contain maximum amounts of Potassium in July during the early growing period, but *Trapa* showed very little potassium from February to June during its early growth period. In *Ceratophyllum* two peaks for potassium were found. One in April and the other in September. Young plants of *Nymphaea cyanea* recorded very little potassium in the beginning in August but quite contrary to this *Nelumbo nucifera* was found to contain maximum during early period of growth in February.

Sodium : The seasonal variation of sodium in plants corresponds to that of potassium. The young offsets of *Pistia stratiotes* were found to contain maximum sodium in February and April. Two peaks for sodium were observed in *Eichhornia*, *Pistia* and *Ceratophyllum.* The first peak was observed in April in *Pistia*, and *Ceratophyllum* and the second in September. Sodium concentration was maxmium at maturity in *Trapa bispinosa* and after flowering the concentration declined considerably. In *Hydrilla* the sodium content was lesser than the surrounding water.

Nitrogen : The total nitrogen content increased as plants grew older as found in *Hydrilla*, *Nymphaea*, *Nelumbo* and *Ceratophyllum.* In *Nymphaea* and *Nelumbo* nitrogen increases along with growth and young plants were found to contain the minimum.

DISCUSSION

In general the concentration of calcium in plants decreased from February to April in correspondence with the decrease of calcium in water. The calcium content of *Najas* however showed an opposite trend perhaps due to regeneration.

The seedlings and young plants of *Pistia*, *Trapa* and *Nymphaea* were found to show very little calcium and the concentration of calcium in-

TABLE 1

SHOWING SEASONAL CHANGE IN THE CHEMICAL COMPOSITION OF SOME AQUATIC PLANTS AND THE SURROUNDING WATER

Species	Month of collection	% of Ash	% of Silica	Total Nitrogen %	Calcium		Magnesium		Sodium		Potassium	
					Plant %	Water ppm.	Plant %	Water ppm.	Plant ppm.	Water ppm.	Plant ppm.	Water ppm.
Eichhornia crassipes	Feb.	17	2·2	2·45	7·48	44·5	6·7	44·0	125	45·5	500	21·0
	June	33	21·4	2·80	5·30	18·0	4·36	53·7	122	55·0	510	20·0
	July	28	8·2	..	4·76	28·0	4·14	42·5	128	55·0	900	33·0
	Sep.	2·6	18·0	..	4·92	47·0	1·09	25·0	125	37·5	860	18·0
	Nov.	8·0	..	..	6·50	..	4·69	..	118	..	460	..
Pistia stratiotes	Feb.	21·0	3·2	2·22	5·4	46·0	8·7	46·0	265	54	520	21·0
	April	20·2	8·0	5·07	4·92	48·0	3·7	55·0	265	58	440	25·0
	July	24·6	0·4	3·31	5·80	14·0	4·3	42·0	138	54	860	35·0
	Sept.	25·6	2·2	..	8·80	46·0	6·2	20·0	212	35	720	21·0
	Oct.	23·44	14·2	..	3·12	56·0	1·8	37·0	162	36	510	22·0
	Nov.	23·2	6·8	..	5·04	24·0	2·0	35·0	165	44	520	23·0
	Dec.	21·0	4·4	..	6·8	44·0	2·18	32·0	168	45	470	19·0
Najas minor	Feb.	26·0	2·4	3·58	12·0	44·8	8·95	44·0	118	45·5	690	21·0
	April	22·0	4·6	..	8·0	18·0	..	53·7	120	55·0	700	20·0
	July	27·8	5·0	3·82	3·78	28·0	4·36	42·5	122	55·0	1500	35·0
	Sept.	..	15·2	4·34	1·86	47·0	2·40	25·0	138	37·5	1400	18·0
Ceratophyllum demersum	Feb.	22	1·6	..	6·6	44·5	..	44·0	25	45·5	560	21·0
	Apr.	23	1·2	3·43	4·4	18·0	5·89	53·7	50	55·0	700	20·0
	June	16	7·4	3·97	8·0	28·0	..	42·5	43	25·0	550	33·0
	Sep.	18.8	9·2	2·94	1·8	47·0	1·74	25·0	53	37·5	1010	18·0
	Dec.	19.0	2·4	4·68	3·0	47·0	6·77	..	43	44·0	1020	20·0

Species	Month of collection	% of Ash	% of Silica	Total Nitrogen %	Calcium		Magnesium		Sodium		Potassium	
					Plant %	Water ppm.	Plant %	Water ppm.	Plant ppm.	Water ppm.	Plant ppm.	Water ppm.
Nelumbo nucifera	Feb.	15·6	6·0	5·07	3·2	44·5	2·62	44·0	122	45·5	700	21·0
	April	12·0	12·0	6·16	3·8	18·0	5·89	53·7	118	55·0	440	20·0
	June	36·0	17·0	4·75	3·4	28·0	..	..	87	55·0	540	33·0
Trapa bispinosa	Feb.	11·4	2·4	4·87	4·0	44·5	3·93	44·0	102	45·5	270	21·0
	April	18·2	2·0	3·15	5·18	48·0	2·62	55·0	102	58	270	25·0
	June	16·0	6·0	3·19	8·4	18·0	0·65	53·7	122	55·0	290	20·0
	Sep.	19·6	6·8	..	3·36	47·0	5·46	25·0	225	37·5	600	18·0
	Oct.	16·0	2·6	..	5·64	56·0	0·43	37·0	125	36·0	380	22·0
Hydrilla verticillata	Feb.	38·0	16·0	1·28	..	44·5	3·7	46·0	87	54·0	440	21·0
	April	15·2	10·4	..	5·56	48·0	4·36	55·0	65	58	425	25·0
	July	20·8	0·4	4·6	3·16	28·0	4·36	42·0	50	54	860	35·0
	Sep.	18·4	4·2	3·74	5·6	47·0	4·69	2·0	50	35	740	21·0
	Nov.	5·0	11·0	..	0·8	24·0	..	35·0	50	36	625	23·0
Nymphaea nouchali	Aug.	14·6	2·0	2·14	2·34	28·0	1·31	..	200	..	460	16·0
	Sep.	19·8	10·4	3·62	2·36	23·0	0·65	25·0	400	37·5	860	18·0
	Oct.	19·2	3·0	3·19	4·04	33·0	1·31	37·0	400	36·0	640	18·0
Spirodela polyrhiza	April	12·0	4·2	..	7·56	48·0	1·09	55·0	100	58	300	25
	June	40·0	20·0	4·75	..	23·0	..	53·7	90	75	510	42
	July	25·0	0·4	..	9·8	14·0	2·8	42·0	53	55	350	35
Potamogeton crasipus	Feb.	24·0	3·4	..	9·66	44·5	4·14	44·0	162	45·5	420	21·0
	April	2·0	0·2	1·20	4·70	48·0	..	55·0	160	58·0	500	25·0

creased later during growth. A decline was found at the time of flowering and fruiting. In terrestrial plants a decrease in concentration before leaf fall is quite common.

Potassium content was very low in the beginning as plants regenerated but at or before maturity this amount increased considerably. At the time of regeneration the ash content was found quite low. No correlation was found between the chemical contents of plants and the surrounding water.

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COLLEGE OF SCIENCE,
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February 3, 1970.

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36. STUDIES IN CYPERACEAE IV. NOTES ON *SCLERIA RUGOSA* R. BR. AND ITS COMPLEX

(*With a plate*)

Among the specimens of Cyperaceae received for study from the Herbarium of the Forest Research Institute, Dehra Dun (DD), was an interesting specimen which can be identified as *Scleria rugosa* R. Br. This taxon in herbariums is usually mis-identified as *S. levis* Retz., *S. zeylanica* Poir., *S. thwaitesiana* Boeck. or *S. flaccida* Clarke. This confusion pertaining to the identity of all the concerned species within this complex is understandable partly in the light of the basic misinterpretation which is evident from the synonymies and the description given for *S. zeylanica* and *S. flaccida* and partly due to the fact that

S. rugosa is supposed to be an Australian species (C.B. Clarke, in Hook. *f.* Fl. Br. Ind. 6 : 688, 1894). As far as *S. rugosa* R. Br. is concerned, it is said to be unknown in India and clearly stated to be an Australian species by Clarke (loc. cit.). However, a presumed relative of this species known as *S. flaccida* Clarke has been described which according to him may perhaps be considered as a variety of the Australian species.

C. B. Clarke (loc. cit.) further points out that *S. flaccida* Clarke and *S. rugosa* R. Br. may be distinguished mainly on the basis of the nut characters which in the former is smooth and non-apiculate while in the latter it is reticulated, subtuberculated and apiculate. It works well as long as the characters remain quite contrasting and divergent but in reality, these presumed differences do not hold good because the nuts as they undergo maturation exhibit certain progressive exomorphic changes corresponding with the degree of their maturation. I could very well observe this in one and the same specimen (*Deshpande* 5, DD). When the nuts are still young and immature, they appear smooth, and polished ; slightly older nuts show obscure superficial depressions especially in the upper half thereby becoming somewhat lacunose (Fig. e); when the nuts that are in the early stages of development get pressed during the curatorial processes, they tend to develop wrinkles and folds thereby assuming rugose or rugulose or subtuberculated condition which seems to be an artefact. During all these stages of development, the colour of the nut continues to be white sometimes changing to pale white. On the other hand, when the nuts become fully mature, not only the colour of the nut ultimately changes over to plumbeous or black with three dark bands (Figs. c, d) but the abovementioned surface sculpturings and artefacts totally disappear and thus become smooth and also in this stage they are covered by several dull brown patches (Figs. c, d). Disc consists of three distinct spreading lobes (Fig. f) when nuts are young while in the mature nuts, each lobe becomes reflexed (Fig. d). In the light of these facts, it is futile and unreliable to give emphasis to this changing character of the nut and employ it for circumscribing the species. But for this undependable character, there is no other character available to differentiate satisfactorily *S. flaccida* from *S. rugosa* and since the former happens to be a younger binomial and superfluous it is to be treated as a synonym of *S. rugosa* R. Br. (*vide* ICBN, Art. 63, 1961). Furthermore, it is invalidated because the binomial *S. flaccida* Clarke is a later homonym (*vide* ICBN, Art. 64, 1961).

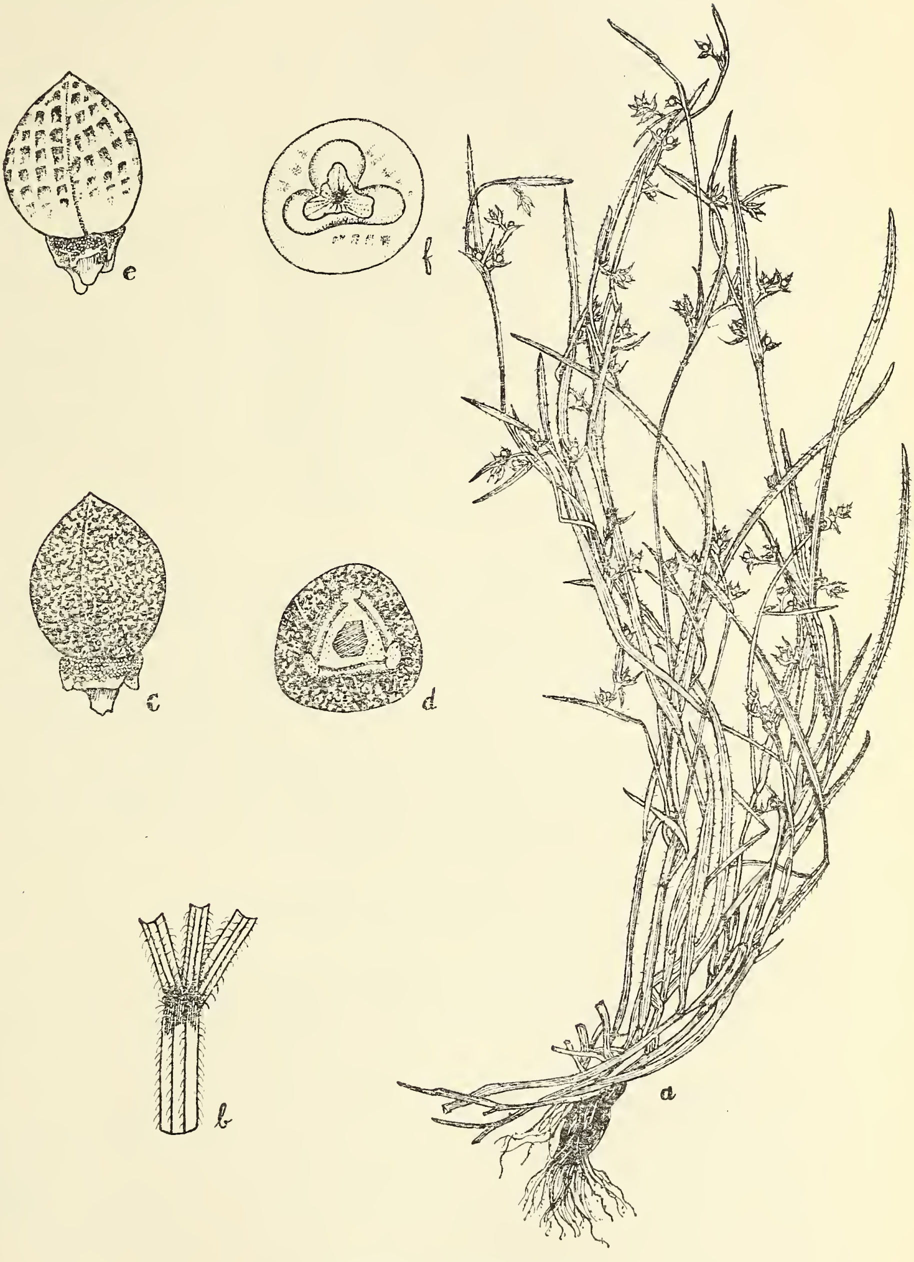
According to Hooker (in Trim. Handb. Fl. Ceyl. 5 : 597, 1900) there are three forms of *S. zeylanica* Poir., in Herb. Peraden. under Nos. C. P. 3318, 3796 and 3797. Out of these three forms, C. P. 3797 becomes the type of *S. thwaitesiana* Boeck. *S. zeylanica* (*non* Poir.) Clarke, Fl. Br. Ind. 6 : 687 *pro parte, quoad specim.* C.P. 3797 and C. P. 3796 is the type of *S. lateriflora* Boeck. which is conspecific with *S. rugosa* R. Br. but wrongly cited by Clarke (loc. cit.) under *S. zeylanica* Poir. Thus, it is clear that the so-called *S. zeylanica* Poir. *sensu* Clarke represents a combination of two distinct species (*S. thwaitesiana* and *S. rugosa*) but each one has got nothing to do with the other. In other words, *S. zeylanica* Poir. *sensu* Clarke embraces both *S. thwaitesiana* Boeck. and *S. rugosa* R. Br. (*S. lateriflora* Boeck.) as could be seen from the synonymies and description. As pointed out by S. T. Blake (J. Arnold Arb. 35 : 226, 1954), *S. zeylanica* Poir. is in reality not only a synonym of *S. levis* Retz. but becomes totally different from both *S. thwaitesiana* Boeck. and *S. rugosa* R. Br. In the light of these considerations, it is considered that both *S. flaccida* Clarke and *S. lateriflora* Boeck. are conspecific with *S. rugosa* R. Br.

As far as the distribution of *S. lateriflora* is concerned, it occurs rather commonly in moist low country below *c.* 333 m (Kukul ?) Korale, Ratnapura, Hewawisse (not Hewesse), in S. Ceylon and flowers in April and July while *S. flaccida* Clarke is available in Assam and Pegu. *S. rugosa* R. Br. is said to be widely distributed in Ceylon and India without indication to specific locality, contrary to what has been said by Clarke (loc. cit.) (Kern, Blumea, 9 : 207, 1961). But in this connection, it is interesting to note that the specimen (*Deshpande* 5, DD) has been collected from Jagdalpur, Bastar in south Madhya Pradesh, a new locality for this taxon hitherto unknown within India. Apart from India, this species is also widely distributed in N. and N. E. Australia, Borneo, S. China, Formosa, Japan, W. Java, Lesser Sunda Islands, Malay Peninsula, Moluccas, New Caledonia, New Guinea and Philippines at low altitudes up to 500 m.

As *S. rugosa* R. Br. is a new and interesting record to India, a full description together with synonymies follows :

Scleria rugosa R. Br. Prodr. Fl. Nov. Holl. 240, 1810; Kunth, En. Pl. 2 : 358, 1837 ; Steud. Syn. Pl. Glum. 2 : 179, 1855; S. T. Blake, J. Arnold Arb. 35 : 226, 1954; Kern, Blumea, 9 : 206, 1961 *et* Adansonia, 108, 1962 ; *S. lateriflora* Boeck., Linnaea, 38 : 455, 1874; *S. flaccida* C. B. Clarke, in Hook. *f*. Fl. Br. Ind. 6 : 688, 1894, *non* Steud. (1855) ; J. Linn. Soc. Bot. 34 : 98, 1898 *et* Ill. Cyp. t. 127, f. 3–5, 1909 ; *S. zeylanica* (*non* Poir.) C. B. Clarke in Hook. *f.* Fl. Br. Ind. 6 : 687, 1894, excl. syn. *S. thwaitesiana* Boeck. *et S. lateriflora* Boeck.; J. Linn. Soc. Bot. 34 : 98, 1898.—Figs. a–f.

Annual, monoecious. *Roots* purplish red. *Culms* many, tufted, slender, triquetrous, tripterous, obliquely ascending, hispid and leafy



Scleria rugosa R. Br.

a. Habit × ½; *b.* Node with contraligule × 1½; *c.* Nut × 12; *d.* Nut (seen from below) × 13; *e.* Nut × 12; *f.* Nut (seen from below) × 14. (From *Deshpande* 5, DD).

throughout, 10-30 cm × 1-2 mm. *Leaves* lorate, densely pubescent with hispid hairs on the margin and nerves, 6-10 cm × 2-4 cm; sheaths triquetrous, gradually widening towards the top, hispid; contraligule short, semi-orbicular, hispid on the margin. *Inflorescence* terminal and pseudoterminal, short, panicle, usually geminate (solitary); peduncles usually reflexed (erect), hairy, somewhat winged; primary bracts erect, foliaceous, usually overtopping the inflorescence. *Spikelets* unisexual; male spikelet short, up to 2 mm long; stamen 1; anther oblong, 0·5-0·7 mm long; connective prolonged into a short, smooth appendage; female spikelets 3-4 (–6) mm long. *Glumes* triangular (ovate), acute, hispid on the keel. *Disc* 3-lobed, closely and densely glandular; lobes reflexed (when mature) or distinctly lobed, spreading, obtuse, rounded (when young); gynophore (cupule) small, somewhat lobed (when young), almost entire (when mature). *Nut* globose, shorter than glumes, umbonulate, obscurely rugulose-lacunose in upper half, white, obscurely tricostulate (when young), smooth, plumbeous or black, marked by 3 dark bands and covered by dirty brown patches (when mature), 1-1·5 mm broad.

Kern (loc. cit.) says that this is a variable species with respect to the representation of the trichomes, surface of nuts and sheaths. But it may be mentioned that as far as the Indian specimen of this species is concerned, this is undoubtedly a densely hairy species developing smooth nuts and almost wingless sheaths. Nevertheless this taxon can be satisfactorily distinguished from its close relative *S. thwaitesiana* Boeck. by the smooth appendaged connective of the anther, entire gynophore, glandular disc with reflexed lobes, plumbeous or black umbonulate nuts covered by dirty brown patches.

ACKNOWLEDGEMENT

I express my thanks to the Officer, Herbarium of the Forest Research Institute, Dehra Dun, for giving me the opportunity of examining the specimen.

DEPT. OF BOTANY,
PRESIDENCY COLLEGE,
MADRAS-5,
November 16, 1971.

E. GOVINDARAJALU

37. A NEW *CEROPEGIA* LINN. (ASCLEPIADACEAE) FROM SAHYADRI RANGE IN MAHARASHTRA STATE

(*With a plate*)

Ceropegia noorjahaniae sp. nov.

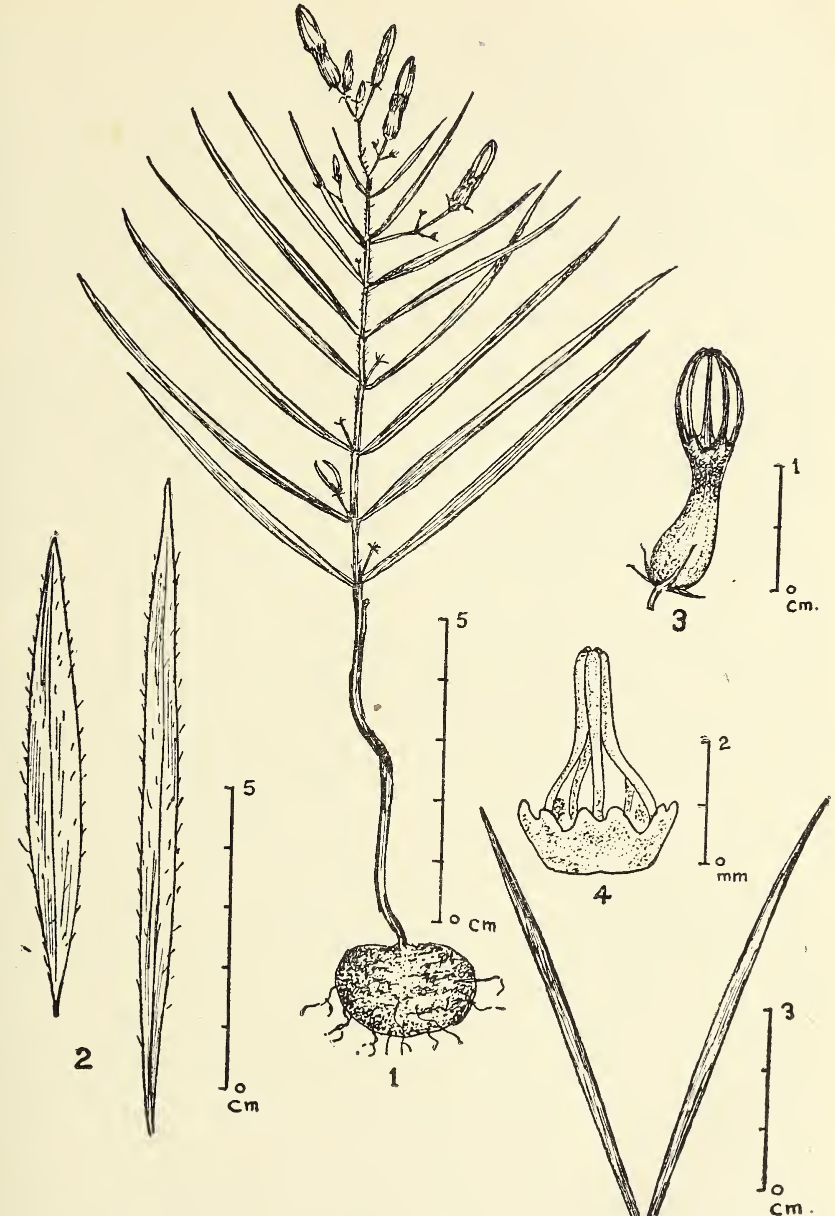
Pertinet ad sect. *Tiloris* Huber, series *Attenuatae* Huber, similis *Ceropegiae fimbriiferae* Bedd. differt tamen lobis corollae glabris sine capillis purpureis basalibus, corona exteriori glabra, interiori recta apice non-convergenti vel non-hamati.

Holotypus (*Ansari* 104880A) et isotypi (*Ansari* 104880 B-K) lecti ad Wai-Panchgani ghat in dist. Satara in ditione Maharashtra die 5 Augusti anni 1970; holotypus positus in CAL; isotypi 104880 B-D in BSI, E in CAL; F in K; G in L; H in BLAT; I in MH; J in LE et K in MO; paratypi (*Ansari* 105098 A-B) lecti eodem loco die 16 Julii anni 1969 positi in *BSI.*

Ceropegia noorjahaniae sp. nov.

Belongs to section *Tiloris* Huber, series *Attenuatae* Huber, and is similar to *Ceropegia fimbriifera* Bedd., but differs in its corolla lobes being glabrous, without any purple hairs at base; outer corona glabrous, inner corona erect with apex straight, non-convergent or non-hooked.

An erect perennial herb, 15-40 cm high with a sub-globose tuberous root. Stem terete, minutely pubescent in the upper, glabrous in lower region. Leaves opposite, subsessile or petiolate; petiole 4-7 mm long, glabrous; linear leaves 9 × 0·3 cm linear-lanceolate or lanceolate 7 × 1·5 cm, acute at apex, tapering at base, hairy on the upper side, glabrous beneath except along mid-ribs, margins minutely hairy. Flowers usually 3, in axillary or extra-axillary umbellate cymes; peduncles 3-4 mm long, terete, glabrescent to glabrous; bracts subulate, 2-2·5 mm long; pedicels 6-7 mm long, glabrescent to glabrous. Calyx 5-partite, lobes 4 mm long, glabrous. Corolla 2-2·7 cm long, slightly curved; tube 1·2-1·4 cm long, inflated at base, in lower ½-⅔ part, externally pale green in the lower ¾ part, pale to dark purplish-brown in the upper ¼ part up to the basal part of the corolla lobes, inside green with longitudinal purple lines, completely glabrous; lobes 0·9-1·3 cm long, nearly equal to the tube, linear oblong with acute apex and deltoid base, greenish above, pale to dark-purplish-brown near the base, margins partly reflexed all along, completely glabrous (without any long purple hairs at base) connate at tips, forming an ovoid head,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Ceropegia noorjahaniae sp. nov.

1. The whole plant; 2. Showing variations in leaves; 3. A flower; 4. Outer and inner corona; 5. A pair of follicles.

Corona biseriate; outer corona cupular, of 5 bifid or deeply emarginate lobes ± 1·25 mm long, 3 mm across, purple, glabrous outside and along the margins; inner of 5 erect, pale-purple, processes, 3 mm long, glabrous, straight at tips (neither convergent nor hooked). Pollen masses erect, minute, yellow, attached to brown pollen carriers by very short caudicles. Pistil ± 1·5 mm long. Follicles in pair, 9×0·4 cm long, tapering at both ends, glabrous. Seeds many, ± 3·5×2·5 mm, ovate, margined; coma 20 mm long.

Flowers: July-August. *Fruits*: August-September.

The holotype (*Ansari* 104880A) and the isotypes (*Ansari* 104880 B-K) were collected along Wai-Panchgani ghat (on the upper slopes between milestones 10/3 and 10/4) in Satara district, Maharashtra State, on 5th August 1970. The holotype is deposited in CAL; the isotypes 104880 B-D in BSI; E in CAL; F in K; G in L; H in BLAT; I in MH; J in LE et K in MO. The paratypes (*Ansari* 105098 A and B) collected from the same locality on 16th July, 1969, are deposited in BSI.

Under the series *Attenuata* of section *Tiloris*, Huber (1957) records 3 erect forms with linear or linear-lanceolate leaves, namely *Ceropegia spiralis* Wt., *C. fimbriifera* Bedd. and *C. attenuata* Hook., all from India. Of these, the first two are so far reported from South India only and the last from Maharashtra and has not been located beyond North Kanara southward. Whereas *C. spiralis* has been keyed out as having stem and leaves glabrous, *C. fimbriifera* and *C. attenuata* are bracketed under stem and leaves more or less hairy. Of these 2 species the former has cymes 1-4-flowered with corolla lobes having long purple hairs at the base, whereas the latter has cymes uni-flowered and corolla lobes pubescent from inside with fine hairs all along the margins or glabrous sometimes. The present species has cymes 1-3-flowered and the flowers are more similar in outline to *C. fimbriifera* than to *C. attenuata*. However, it is quite distinct from both of them as the salient features of these 3 species, tabulated below, suggest.

	C. fimbriifera	*C. noorjahaniae*	*C. attenuata*
1.	Cymes peduncled, 1-4-flowered.	Cymes peduncled, 1-3-flowered.	Cymes sessile or minutely peduncled, uni-flowered.
2.	Peduncles 5-25 mm long, glabrescent to glabrous.	Peduncles 3-4 mm long, glabrescent to glabrous.	Peduncle 1-2 mm long, hairy.
3.	Flowers 2·5-4·0 cm long.	Flowers 2-2·7 cm long.	Flowers up to 7·5 cm long.

4. Corolla tube green, base moderately inflated.	Same as *C. fimbriifera*.	Corolla tube pale yellowish-green, base slightly inflated.
5. Corolla lobes pale greenish-purple with tufts of numerous-long, purple, hairs between the segments at the base ; about equal to tube.	Corolla lobes greenish above, pale to dark purplish brown near the base, completely glabrous ; almost equal to the tube.	Corolla lobes pale-purple in the upper half, merging to pale green below, margin finely hairy all along and pubescent inside, folded on the back ; mostly longer than the tube.
6. Outer corona ciliate along the margins.	Outer corona glabrous along the margins.	Outer corona ciliate along the margins.
7. Inner corona long, ligulate, erecto-convergent or slightly hooked (Bedd. Ic. Pl. t. 172, 1874).	Inner corona erect, apex straight (neither convergent nor hooked).	Inner corona spathulate, completely divergent (or getting hooked in old flowers).

This species was found on the ghat slopes along with grasses and herbs and grows well in well-drained soil. It is difficult to locate even when in full bloom, as it is completely covered and camouflaged by tall grasses, besides being rare and grows during peak monsoon season, thus rendering its collection more difficult. Under cultivation, it tends to develop a climbing habit in the later stages of its growth, due to continued watering, a feature common to many erect forms.

Etymology :

It is with utmost sense of affection that I dedicate this species to my wife, Noorjahan, who is no more with me as a source of light (Noor) and inspiration in my explorations and botanical study.

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BOTANICAL SURVEY OF INDIA,
POONA-1,
June 26, 1971.

M. A. ANSARI

REFERENCES

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ERRATUM

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Miscellaneous Note 2

In line 4 of para 2 for Largactil *read* Lactogen.

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Home Range and Food Habits of the Nilgiri Langur, *Presbytis johnii*

BY

Robert H. Horwich
Chicago Zoological Society, Brookfield, Illinois, U.S.A.

(*With two text-figures*)

The disastrous effect of replanting Eucalyptus trees in place of natural forest in South India for short term economic benefits is rapidly causing the deterioration of the fauna indigenous to South India (Daniel & Kannan 1967). The Nilgiri langur, *Presbytis johnii*, is one such endangered species. This monkey is endemic to the evergreen shola areas in the Nilgiri mountains, where I studied it in an effort to understand some of its ecological needs as an aid to its preservation.

This paper offers data on the food habits and home range of three troops of langurs that were studied at Periyar sanctuary in Kerala from March 20 to May 13, 1968, for about 270 contact hours. The period of study just prior to the rainy season, was one of transition in vegetational growth, which enabled observations to be made on the changing diet of these monkeys.

When located, each troop was usually followed and continuously observed with 8×35 binoculars. If observations were terminated temporarily, the troops could usually be found again and observations were resumed. During ten observation days, troops were continually under observation from sun-up to sundown except for a short break in the morning and around noon. Visual sighting of food choices were made and leaf remnants were then immediately collected from the ground after the troop had moved to another area.

RESULTS

Home Range and Territoriality

The three troops which were studied numbered 27, 7 and 21. They were located in that order on a long peninsula of deciduous and evergreen forest which extended into the man-made sanctuary lake from the north. The peninsula area studied was approximately 1·5 km long by 0·3 km wide (Fig. 1). Troops on this same peninsula were studied in 1963 by Tanaka (1965). The areas occupied by his troops B, C and D (numbering 14, 13, 25) correspond almost exactly to the areas of my Troops 1, 2 and 3. Although there is no other evidence of these being the same troops, there is a constancy of the home range areas. At least this allows a comparison of the utilization of the same areas by two troops of different sizes (although historically they may represent a single troop). At no time during the two month study was any troop seen out of the home range areas designated nor in any other troop's home range except in the border overlap zones. This observation leads me to the belief that home range and territory in this species are essentially synonymous.

Fig. 1*a* and 1*b* shows the continuously observed trails of each of the three troops and those of one lone male. The concentration of the trails shows the localization of movements around certain preferred feeding and resting areas (' core areas ', Kaufmann 1962). Although they had a number of general areas preferred for midday resting or night time sleeping, they were not absolute in their choice and these probably changed seasonally. In contrast, Common langurs, *Presbytis entellus* (Jay 1965; McCann 1933; Prater 1948) and *Colobus guereza* in Africa (Marler 1969) seem to be more rigid in returning to their sleeping sites. The *Colobus* were apparently faithful for periods as long as five years.

The core areas of the Nilgiri langurs seem to change seasonally depending on the availability of preferred food. A map displaying the two main vegetation types (Fig. 2), when compared to Fig. 1*a* and 1*b*, shows that most of the activity in all three troops during this deciduous growth season was confined to the deciduous areas. Earlier data on a troop in Troop 3 territory (Tanaka 1965) in contrast, shows a preference for the evergreen areas during January and February. Tanaka's troop often slept the night in the northeast area where my lone male sometimes rested in the midday (Fig. 1*a*). Common langurs in North India also show this shift in core areas between use in the dry season and the monsoon season (Jay 1965).

Table 1 exhibits the difference in area used by the three troops. Excluding non-forested areas or built-up areas, each troop had available for use 5·0-7·1 hectares of which only 34-67% was used or 2·3-3·9 hectares per troop. This represents ·11 - ·56 hectares per individual available. These data seem to indicate that the amount of the territory used doesn't depend on the size of the troop, probably because the troop acts as a unit and food was plentiful at this time of the year. The smallest troop, Troop 2, travelled greater distances in general and was much more erratic than the other troops, which moved in a very regular characteristic manner similar to an accordian, with the first half of the troop moving and then resting or eating while the other half remained eating and resting and then eventually followed. As they rejoined the first half, the latter would just be beginning to move.

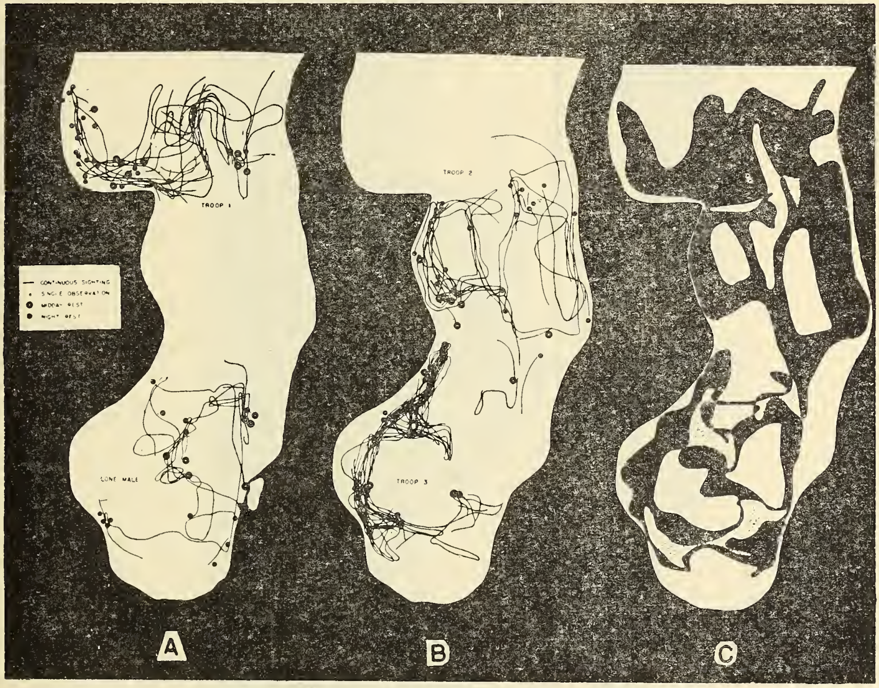


Fig. 1. Home ranges of three troops of Nilgiri langurs and a lone male on the peninsula at Periyar.

(A) Continuous trails of Troop 1 (top) and lone male (bottom);

(B) Continuous trails of Troop 2 (top) and Troop 3 (bottom);

(C) Home ranges of Troops 1, 2, 3 and lone male (in black) and the overlap zones between troops (stippled).

In addition, judging from Tanaka's (1965) work, although the territory size doesn't appear to have changed, the troop size within each territory did change considerably (Table 1). This again indicates no correlation of troop size to territory size, contrary to Poirier's (1968b; 1970a) beliefs. Poirier also mentioned that the concentration and type of food plant in the home range played a major role in determining its size. A comparison of the gross estimates of evergreen and deciduous

TABLE 1

ASSESSMENT OF AREA AND ANIMALS FOR EACH TROOP OF LANGURS OBSERVED

Troop	Total area (hectares)	Area open for use (hectares)	Area used (hectares)	% Area used	Hectares/ individual available	% Evergreen/ deciduous within area used	Hectares evergreen/ deciduous within area used	Troop size
1	5·6	5·0	3·4	68	·13	40/60	1·4/2·0	27 (14)
2	7·3	7·1	3·9	55	·56	40/60	1·6/2·3	7 (12-13)
3	8·3	7·0	2·3	33	·11	60/40	1·4/ ·9	21 (25)

Figures in parentheses represent data collected by Tanaka (1965) on troops studied in the same home range.

hectares used (Table 1), supports this view. A relatively constant amount of evergreen forest was used per troop (1·4-1·6 hectares). Since the monkeys are wasteful of the food and since neither Poirier (1968b) nor I noted a lack of food, then perhaps a certain area of evergreen forest may be necessary for each troop for some reason other than food.

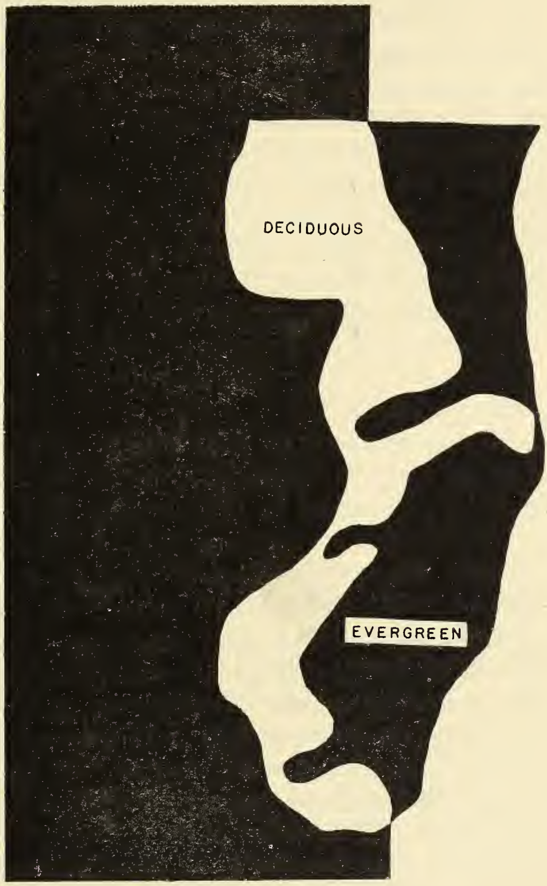


FIG. 2. Vegetational map of the peninsula.

Fig. 1*c* shows the zones of overlap and the relationship of troop territories to each other. These areas are small defended overlap areas similar to those noted in Lutongs, *Presbytis cristatus* (Bernstein 1968), the African *Colobus guereza* (Marler 1969), and South Indian Common Langurs (Yoshiba 1968). The Nilgiri langur male actively defends these borders against adjacent troops. Defence of these territories was noted between adjacent troops on 5 occasions, 4 of which were between Troops 1 and 2. The displays, vocalizations and chases in these cases directly involved only the single adult male of each troop. Typically, each of these males would sit on a high tree branch, open his mouth exposing his lower incisors and emit a continual low-pitched buzz which sounded like a creaking door (creaking mentioned by Poirier 1968a). This would be answered by the other male from about 25 metres away or more. The males may also give a quick movement of the head upwards while keeping their mouth open and closing it slightly as if biting the air. This is similar to behaviour exhibited by both males and females toward human intruders. Then one male would run toward the other often giving whoops, grunts, hiccups, or hahhah (hoho) calls (see Poirier 1968a) which are all indications of an excited state in the langurs as all of these calls were heard as an alarm response to a human intruder. One male would chase the other into its territory only to be chased immediately back to its own territory. A similar chase exchange occurs in South Indian Common langur one-male heterosexual groups (Yoshiba 1968). After the confrontation, the Nilgiri troops then moved in opposite directions into their respective territories. A specific indication of a territory overlap from these troop interactions is seen in Fig. 1*c* at the top right which was due to the violation of Troop 2 territory by Troop 1 male during these interactions.

As noted in Fig. 1*c*, except for this area of territorial disputes, cohabitation of an area is rare. However, between Troop 3 and the lone male who could be recognized by the missing middle finger on his left hand, there was considerable overlap. This male was thought to be a young adult male who was displaced from the troop by the dominant male of Troop 3. This is based on: (1) his close association with Troop 3, (2) great amount of male to male aggression in Nilgiri langurs (Poirier 1969; 1970a; 1970b) and (3) lone male Nilgiri langurs and Common langur non-group males show scars on faces and bodies as a result of fighting, which may indicate their displacement from the troop (McCann 1933; Yoshiba 1968). This scarred male performed all activities alone and was forced into the evergreen areas by the movements of the main Troop 3. He kept clear of the main troop most of the time. In comparing Fig. 1*a* and *b* with Fig. 1*c* one can see that the areas of overlap were not part of the lone male's areas of main usage. Similarly, in the North Indian common langur, non-group males which overlap the range of the bisexual troop will avoid using the overlapping areas when the troop is nearby (Jay 1965).

The only times the lone male approached Troop 3 was on three occasions in which he seemed interested in establishing friendly contacts with the young juvenile males in Troop 3. This is another indication that he was probably a member of Troop 3 at one time. In all observations of all troops it was only the males which seemed to stray from the main troop to any degree. The adult male would occasionally move a distance from the troop in order to feed from a particular tree. In one case, Troop 2 male seemed to lose his troop and upon noting it directly across the road from him where no tree pathways existed, he raced about 365 metres in 10 minutes, up one side and down the other side of the road in the tree pathways to rejoin the troop, pausing to stop on a number of occasions. The three juvenile males of Troop 3 were also seen to wander a short distance away from the troop on three occasions ; on two of these they were joined by the lone male. During these periods the lone male approached the juveniles, giving coughs, uh-uh sounds, and a musically modulated sound expressed phonetically as eh-uh-ol. The juveniles seemed to pay him very little attention but would move away when he came too close. In the third instance the lone male was seen eating near three juvenile males but he made no attempt to join them and later moved away. This may be a possible rudimentary beginning of an all-male troop formation which exists in Nilgiri langurs (Poirier 1970*a*), common langurs (Ripley 1967; Jay 1965; Nolte 1955), and *Presbytis cristatus* (Furuya 1961-62).

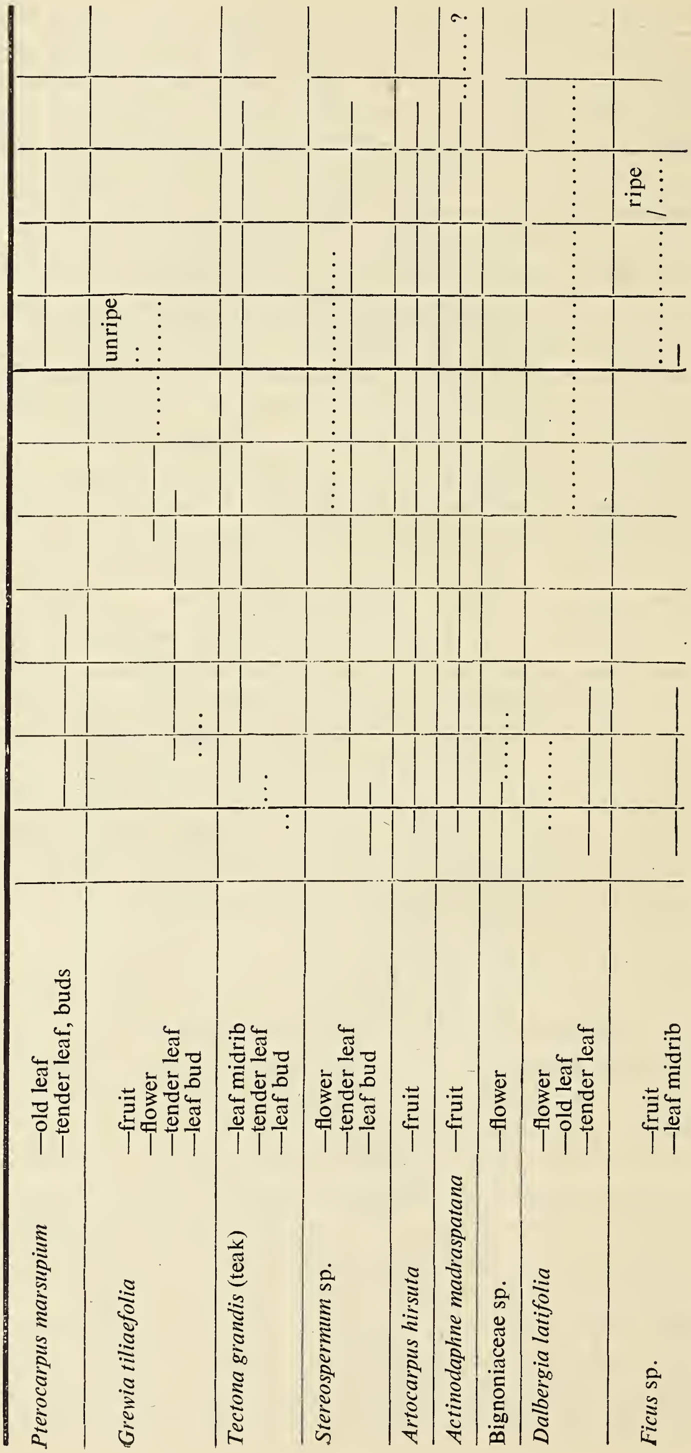
Food Utilization and the Changing Diet

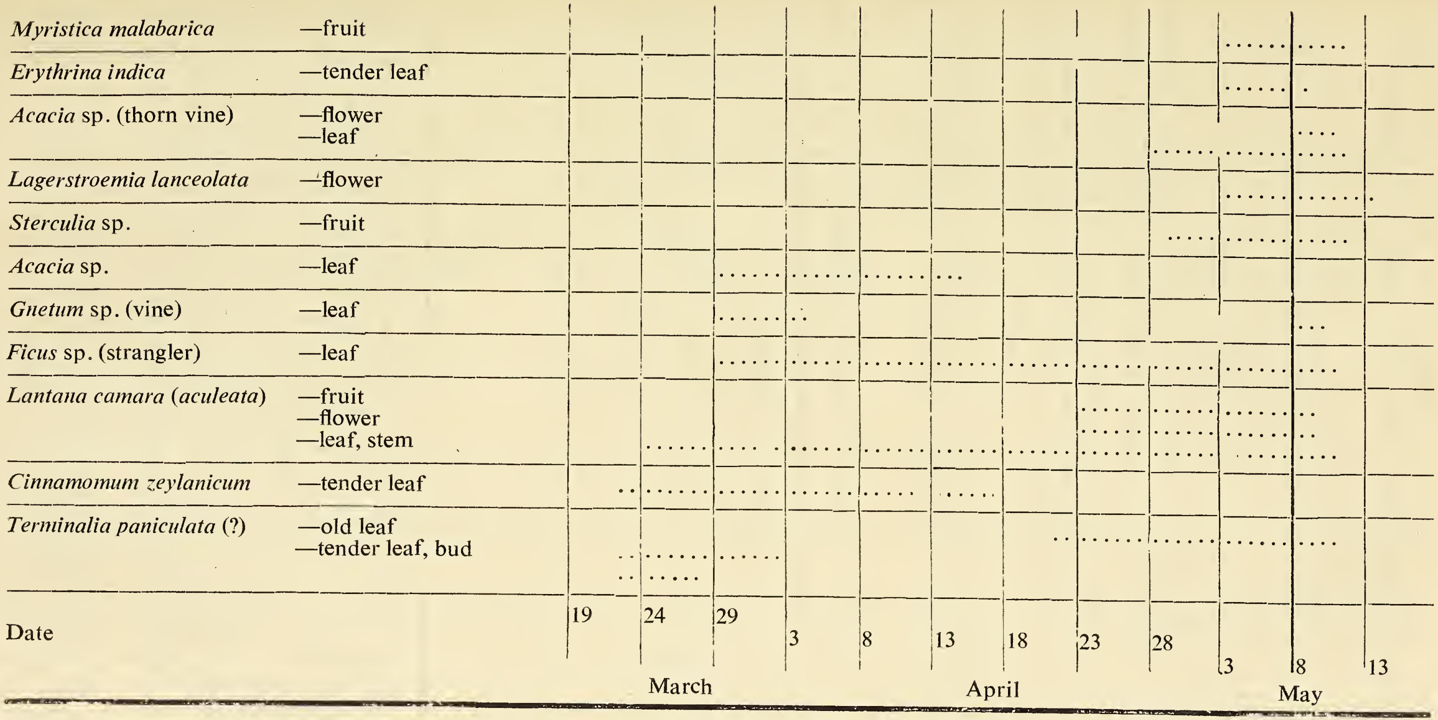
The main areas utilized for feeding and resting were the deciduous areas since it is at this time of year that the vegetation changes radically. During the study periods new buds, leaves, and flowers of the deciduous plants were emerging and the general food habits changed with the plant growth. Table 2 shows the general transition in feeding that took place. During late March and early April the tender new leaves of *Pterocarpus marsupium*, *Grewia tiliaefolia*, *Stereospermum* sp., and *Dalbergia latifolia* were eaten along with leaves and leaf midribs of *Tectona grandis* and *Ficus* sp. as well as fruits of *Artocarpus hirsuta* and *Actinodaphne madraspatana*. By mid April the main diet had narrowed to just teak (*Tectona grandis*) leaves, Aini (*Artocarpus hirsuta*), fruits of *Actinodaphne madraspatana* and a return to older leaves of *Pterocarpus marsupium*. These langurs seem to show a greater variety of foods eaten than common langurs in Ceylon, which, during any one point in the seasonal cycle, eat about 1 to 4 staple items plus 3 to 8 items in lesser quantities (Ripley 1970).

In general, tender leaves and buds, fruits, and often flowers were the preferred parts of the plants. In reference to individual plant species certain aspects of the plant were preferred and eaten when they emerged. Certain food preference progressions are very noticeable in Table 2, particularly in *Pterocarpus*, *Grewia* and Teak. *Grewia tiliaefolia* presents the best instance of seasonal progression of food preference in one plant species. The leaf buds were taken when they first developed March 27-29 after which the tender leaves were eaten from March 29-April 15. By this time the leaves were well developed and the

TABLE 2

SPECIES OF PLANT EATEN BY NILGIRI LANGUR



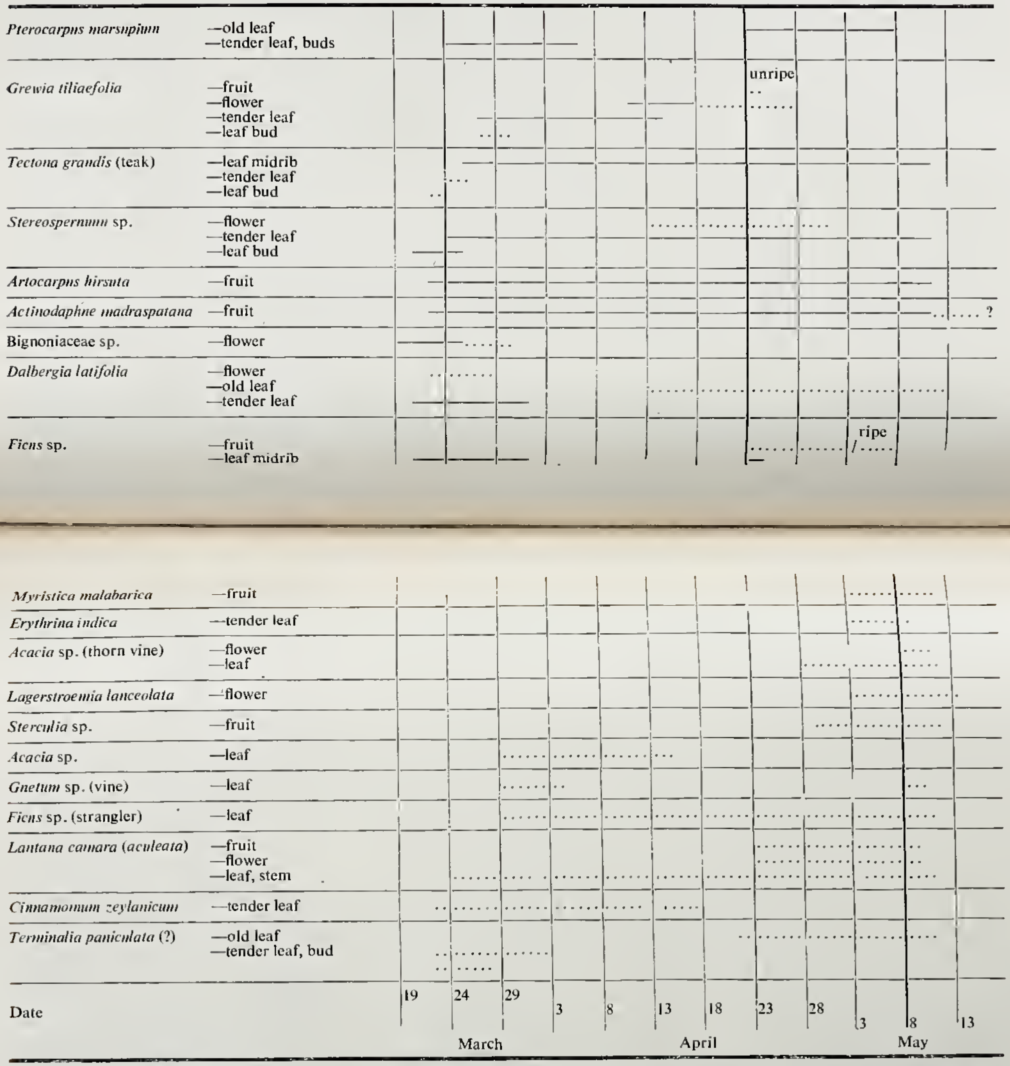


——— =main part of diet ; .... =supplementary part of the diet.

Also eaten : *Bischofia javanica* leaf ; bamboo leaf ; *Gmelina arborea* flower ; fern leaflet ; *Mangifera indica* (wild mango) leaf ; Myrtaceae fruit ; *Macaranga peltata* leaf ; *Phyllanthus emblica* leaf ; *Callicarpa tomentosa* flower ; *Litsea* sp. tender leaf ; *Ficus* sp. fruits ; Oleaceae (*Ligustrum* ?) leaf ; Rubeaceae leaf ; Myrtaceae leaf ; Leguminaceae vine ; Dilleniaceae (*Dillenia* ?) leaf ; *Entada* leaf midrib ; *Meliosma wightii* (?) leaf ; *Vernonia monosis* (?) leaf.

TABLE 2

SPECIES OF PLANT EATEN BY NILGIRI LANGUR



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langurs ate the flowers almost exclusively from April 13-26. Their interest in *Grewia* decreased until only occasionally were unripe fruits taken around April 25-26.

In regard to the fully developed tender leaves and older leaves of certain species only parts of the leaf were preferred. Indication of this can be seen in analyzing leaf fragments discarded by the langurs which were collected from the forest floor. Langurs preferred only the proximal stem end and the midribs of the teak leaf although they would eat the whole leaf occasionally. This part was tougher and tasted more sour and bitter to the observer than the softer blade of the leaf. Poirier (1970*a*) also noted that most food eaten had a distinctly bitter taste. Table 3 shows the part of the leaf eaten relative to the size of the leaf. These leaves were collected randomly from loose leaves under langur feeding spots.

Table 3 indicates that the larger teak leaves are the ones most frequently taken and eaten. Of these only the proximal stem tip is eaten or the tip and the midrib are eaten. The leaf stem is held in the mouth and then one side of the leaf at a time is torn back and discarded or left hanging until $\frac{1}{2}$-$\frac{3}{4}$ of the midrib is eaten and the uneaten part is then discarded. This whole process takes about 25-30 seconds per leaf to perform and is done continuously with 5-10 seconds between leaves. When eating the whole leaf the langur grasps the leaf in one hand which rolls the leaf together and the langur then takes a bite from the rolled leaf until it has either finished the leaf or lets the remaining part drop.

TABLE 3

AMOUNT AND SIZE OF TEAK LEAVES PREFERRED

	Amount of Leaf Eaten					
Leaf size, length in mm	untouched	ripped only	bitten	$\frac{1}{4}$ eaten	$\frac{1}{2}$ eaten	$\frac{3}{4}$ eaten
25	2	..	..	..	..	..
50 – 75	1	..	..	..	..	..
75 – 100	1	..	..	..	..	..
100 – 125	4	..	..	..	..	..
125 – 150	1	1	..	..	..	..
150 – 250	..	..	2	20	..	..
250	1	..	..	29	..	..

Table 4 shows similar preference in a species of *Ficus* which had leaves covered with reddish fuzz. Most of the leaves taken were 75-150 mm and the langurs seemed to prefer the 105-125 mm ones of

TABLE 4

AMOUNT AND SIZE OF *Ficus* LEAVES PREFERRED

	Amount of midvein consumed								
Leaf size Length in mm	untouched	ripped only	'tasted'	Stipules bitten and eaten	$\frac{1}{4}$-$\frac{1}{2}$ ripped and eaten	$\frac{1}{4}$ eaten	$\frac{1}{2}$ eaten	$\frac{3}{4}$ eaten	Total
25	..	..	..	..	..	..	..	..	..
25–50	..	..	..	..	..	..	..	..	..
50–75	3	..	1	1	..	1	1	..	..
75–100	6	..	..	7	13	8	14	9	7
100–125	3	2	2	5	19	10	27	36	31
125–150	1	..	..	1	3	1	6	10	4
150–175	..	..	..	1	..	1	..	..	..

TABLE 5

AMOUNT OF THE ROSEWOOD LEAVES EATEN

Amount of the distal end eaten			
$>\frac{1}{2}$	$<\frac{1}{2}$	$\frac{3}{4}$	$<\frac{3}{4}$
1	7	13	28

which they consumed ½ to all of the midvein. Table 5 shows that most of the rosewood leaf is eaten. That the distal part of the leaf is eaten probably merely means that no part is preferred and they eat whatever was easiest to reach. They eat these leaves by pulling branches of the small leaves toward them, then chew the leaves directly off the branches. This differs from the handling of teak, *Ficus*, and other large leaves which were pulled manually off the branch one at a time and then treated individually. Poirier (1970*a*) mentioned that branches were usually bent towards the monkey and held with a hand or foot while the other hand picked off the leaves. He found that they rarely took food directly into the mouth except for *Acacia mollissima* flowers.

SUMMARY AND CONCLUSIONS

Since Tanaka (1965) visited Periyar Sanctuary in Kerala, the three territory areas occupied by Nilgiri langurs on the southern part of the peninsula at Thekkady have remained the same, yet the troop sizes have changed considerably in two of the areas. This shows the lack of correlation of troop size to territory size. However, the core areas do change with the seasons, with a tendency for troops to forage in deciduous areas during March-May and a tendency to remain in evergreen areas in January-February. During this deciduous feeding period, the developing parts of the plants (buds and tender leaves) were predominantly eaten. Other foods were also eaten and different methods of handling were employed for different food types. Certain resting and sleeping areas, coincident with the feeding areas, were used but the troops were not constant to them. Rather, a certain probability of their usage existed. A lone male was observed which seemed to have been displaced from one troop and ' forced ' into the evergreen areas during feeding of the main troop in adjacent deciduous areas.

ACKNOWLEDGEMENTS

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On the breeding biology of the Blackthroated [*Ploceus benghalensis* (Linnaeus)] and the Streaked (*Ploceus manyar flaviceps* Lesson) Weaver Birds in the Kumaon Terai

BY

V. C. AMBEDKAR

(*With two plates*)

INTRODUCTION

This paper is based on observations of the nesting habits of the Blackthroated Weaver (*Ploceus benghalensis*) and the Streaked Weaver (*Ploceus m. flaviceps*) made during the breeding seasons of 1961, 1962, 1963 and 1968 and is a continuation of the studies on bayas started by Sálim Ali in 1931 and resumed in 1953 (Ali & Ambedkar 1956, 1957 ; Ambedkar 1958, 1964, 1968 ; Ali & Crook 1959 ; Crook 1960, 1963). The initial field work started in Bombay neighbourhood (1931), was resumed in the Poona area in 1953 and extended to Rudrapur, Kumaon terai, Nainital dist., Uttar Pradesh, after the re-discovery there of Finn's Baya (*Ploceus megarhynchus*) in 1959.

METHODS

To obtain comparative data and for evaluating observations on all four species of Indian weaver birds, similar methods were employed in their study with minor refinements dictated by experience. Methods and area of study have been described in earlier papers (Ambedkar 1964, 1968).

Blackthroated Weaver

Ploceus benghalensis

(Plate I)

GEOGRAPHICAL DISTRIBUTION

Ploceus benghalensis is common throughout northern India, Pakistan from Sind through East Punjab to Assam, Manipur and Bangladesh. It occurs in Gujarat and exceptionally further south, Wenden's record from Bhandup (Bombay suburb) being the southernmost for the species Hume (1890). It is very common in Bengal, Bihar and Uttar Pradesh and its nest colonies can be seen all along the North-Eastern Railway tracks in the U.P. terai. I observed them from Saharanpur to Purnea, during the breeding seasons from July to September, but most abundantly between Gonda and Gorakhpur in U.P. Although it is a bird of the lower elevations, there is a record of its breeding at Kurseong (Darjeeling dist.) at about 1300 m (Hume 1890). It is recorded from Nepal terai (Rand & Fleming 1957) but not from any other region or outside India.

ECOLOGY

The Blackthroated Weaver *P. benghalensis* is the commonest *Ploceus* species in the Kumaon terai standing first in order of population density ; it is essentially a bird of flat low-lying, usually swampy areas. At Rudrapur and Pantnagar all the breeding colonies seen were in tall grass (*Saccharum munja* or *Saccharum spontaneum*) and reeds (*Phragmites* sp.) standing in water or on the edge of ponds and ditches. Many colonies were seen along the irrigation canals and river beds. Nests were also abundant along the sides of the highways like those from Pantnagar to Rudrapur, Rudrapur to Kichcha and Rudrapur to Bilaspur. Reeds in wayside ditches and pools in residential compounds, near play grounds and grazing land, and behind hutments were equally favoured, and proximity of human beings was not a deterrent. In the Pantnagar Agricultural University campus colonies were also observed in the hostel compounds ; sometimes they were situated just below the windows, giving excellent opportunities for watching. The colonies were small and widely scattered. I did not find any colonies in the wooded area around Lalkua.

The breeding season commences after the onset of the monsoon and lasts from June to October.

NEST BUILDING

The nests are normally situated between about one and 2½ metres above the ground. For the selection of the nest site and construction of the nest, the male alone is responsible. The male, in breeding plumage, as soon as he arrives in the breeding area selects a site for his nest and begins construction. Selecting a few standing grass stems he pulls them together and ties them up at some height above the ground as if by a waist belt. A similar ' belt ' of interlaced grass strips was also recorded in the construction of reed-bed nests of Finn's Baya (Ambedkar

1968). The nesting materials—strips of *Saccharum munja* or *Saccharum spontaneum* and *Phragmites*—are usually collected in the vicinity.

The ' waist belt ' (Pl. I,a), draws the stems closer together to provide good support for the nest, placed some 15 to 30 cm above it. A wad-like foundation is fashioned, which develops into the most important stage of the nest—the ' helmet ' (Pl. I, b, c). At this stage the male attaches mud-blobs and sticks bright-coloured flower petals into them in the form of rings. These petal rings can be seen from a considerable distance ; their probable function is discussed later. The female usually visits the nest at this stage and if satisfied with the structure accepts it. The male continues construction, with egg chamber towards the grass stems and a long entrance tube on the outer side. As soon as the female begins incubation, the male goes on to construct another nest nearby which is also occupied in due course by a second female. Thus there is the same type of successive polygyny in the Blackthroated Weaver as described for *Ploceus philippinus* (Ali 1931). Usually the male completes the nest within five or six days but the tempo of his building activity depends mainly on the prospecting visits of unmated females.

Due to the weight of the nest, the flexible grass stems bend over, bringing the bottom of the egg chamber parallel with the ground and the mouth of the pendent entrance tube facing downwards (Pl. I,d). This gives better protection to the eggs and young from violent winds as well as making it difficult for nest-robbing predators to enter the nest. No abnormal nests were observed among the colonies.

It is a common sight in the breeding area to see aberrant, incomplete ' practice ' nests built by the immature males of *P. philippinus*, *P. manyar* and *P. megarhynchus*, usually segregated from the breeding colony. Strangely enough nowhere were such half-built nests of juvenile *P. benghalensis* observed. This seems a marked deviation from the behaviour of other species, but it may also imply a difference in the period of maturing between *P. benghalensis* and the other three weavers.

CLUTCH SIZE

Table 1 gives the clutch-sizes of the Blackthroated Baya including the data collected by Sálim Ali and Crook. It shows that out of 110 clutches, 51 clutches or 46·3% belong to size-group of 3.

The mean clutch-size for the years 1959, 1961, 1962, 1963 and 1968 are 3·2, 3·3, 3·5, 3·0 and 3·2 respectively. The mean of five years is 3·2. The seasonal variations in clutch-sizes could not be studied as my visits to the Kumaon terai were brief.

TABLE 1

EGGS PER CLUTCH/NO. OF CLUTCHES

Year	1	2	3	4	5	6	7	Total
1959*	1	2	12	2	4	..	..	21
1961	1	1	9	9	..	..	..	20
1962	1	2	13	11	3	2	..	32
1963	2	4	3	3	1	..	1	14
1968	..	3	14	3	1	1	1	23
Total	5	12	51	28	9	3	2	110

* Data collected by Sálim Ali and Crook.

EGG WEIGHT

Fresh eggs or newly laid eggs were selected for weighing. The heaviest and the lightest weights were 2·7 gm and 1·8 gm respectively. The mean weight was 2·2 gm (35 observations).

INCUBATION

The female, as in other Indian weaver birds, is solely responsible for the incubation of the eggs. At the time of her entering the nest, the male usually greets her with quivering wings, but with lesser vigour and with low intensity as compared with the courtship period. As soon as a female occupies the nest, the male gives the finishing touches to it from outside and often inspects the nest carefully and minutely. He goes on either to lengthen the entrance tube or to construct a new nest nearby for another unmated female.

The female alone does the night brooding, entering the nest before sunset. I observed that in mixed colonies of *P. benghalensis* and *P. manyar*, the males of *P. benghalensis* were the last to leave the colony for the communal roost. In one instance (30th August) the last male left the colony at 6.52 p.m. after which there was complete silence.

TABLE 2

INCUBATION PERIOD

Incubation period days	No. of clutches observed
13	..
14	4
15	9
16	5
17	..

Showing the most frequent incubation period as 15-16 days.
Average for 18 clutches = 15 days.

NESTLING PERIOD

The female Blackthroated Baya feeds the young on small insects, collecting the food from nearby fields. The male usually starts to collect food for the young only when they are about 10-12 days old. During the absence of the female on foraging trips, the male guards his nest and young and was observed chasing off Indian Wren Warblers (*Prinia inornata*) and Whitethroated Munias (*Lonchura malabarica*) from its proximity. In colonies of *Ploceus philippinus*, *Ploceus manyar* and *Ploceus megarhynchus*, the call-notes of the hungry young can be heard from a considerable distance, but *Ploceus benghalensis* young are almost mute and hardly any sound is heard even at close range. This habit probably helps to make the nests with young less vulnerable to predators.

The female removes faecal pellets of the young and drops them outside the colony.

TABLE 3

FLEDGING PERIOD OF THE NESTLINGS

Days after hatching	No. of young flew
14	10
15	11
16	14
17	..
Total	35

Average of period in nest = *c*. 15 days.

On leaving the nest, both male and female attend to the young, at least for a week, feeding them on insects, grasshoppers, etc. The young usually stay near the breeding colony for sometime and then disperse.

WEIGHT OF THE NESTLINGS

Weights of nestlings were taken in the evening after 6.30 p.m. By that time the females had usually stopped feeding them and the males were about to leave the breeding colony for roosting. This was a suitable time for weighing nestlings which showed the maximum weight attained during the day. The weights were taken as fast as I could, so that the females should have enough time to enter the nests for night brooding. The night brooding is very essential for the first few days, as without it the young would die of cold.

The nestlings usually left the nest when their weight reached 20·5 gm (Table 4). The average weight of adults (♂ and ♀) was 23·3 gm.

TABLE 4

WEIGHTS OF YOUNG OF *Ploceus benghalensis* FROM THREE CLUTCHES

I

Age in days	Date	Young		
		I	II	III
1	5-9-1962	3·250	2.2	Infertile Egg
2	6-9-1962	. .	. .	
3	7-9-1962	. .	. .	
4	8-9-1962	9·1	6·6	
5	9-9-1962	11·2	8·2	
6	10-9-1962	12·2	10·3	
7	11-9-1962	14·2	13·4	
8	12-9-1962	18·7	15·6	
9	13-9-1962	20·1	18·1	
10	14-9-1962	22·3	19·6	
11	15-9-1962	. .	. .	
12	16-9-1962	22·2	22·2	
13	17-9-1962	20·5	20·6	
14	18-9-1962	. .	. .	
15	19-9-1962	Flew	20·0	
16	20-9-1962	. .	Flew	

II

Age in days	Date	Young		
		I	II	III
1	19-9-1962	4·1	3·650	Infertile Egg
2	20-9-1962	. .	. .	
3	21-9-1962	. .	. .	
4	22-9-1962	. .	. .	
5	23-9-1962	12·3	11·2	
6	24-9-1962	. .	. .	
7	25-9-1962	17·0	16·5	
8	26-9-1962	19·7	18·3	
9	27-9-1962	. .	. .	
10	28-9-1962	21·2	21·0	
11	29-9-1962	. .	. .	
12	30-9-1962	22·0	21·4	
13	1-10-1962	21·3	19·0	
14	2-10-1962	Flew	Flew	

III

Age in days	Date	Young		
		I	II	III
1	28-9-1962	3·0	2·9	2·2
2	29-9-1962	. .	. .	. .
3	30-9-1962	. .	. .	. .
4	1-10-1962	7·6	7·4	6·4
5	2-10-1962	9·5	9·2	6·4
6	3-10-1962	11·7	10·0	8·3
7	4-10-1962	14·6	13·5	11·2
8	5-10-1962	. .	. .	. .
9	6-10-1962	19·0	18·7	16·0
10	7-10-1962	. .	. .	. .
11	8-10-1962	20·1	19·7	19·0
12	9-10-1962	. .	. .	. .
13	10-10-1962	22·0	20·5	Disappeared
14	11-10-1962	. .	. .	. .
15	12-10-1962	Flew	Flew	

SOME NEW OBSERVATIONS ON THE COURTSHIP

Crook (1963) has described the courtship of the Blackthroated Baya and analysed the sequences fully. He states, ' At the start of breeding, the males keep strictly to their territories, building nests and supplanting intruding neighbours. The females fly into the colony, usually singly but occasionally in small groups, and proceed to hop through the territories and to approach the various nests. Should the male be absent, a female will alight in his nest, examine it, titivate upon it, and then hop on into the next territory. As soon as a male observes an approaching female he leaves his nest and flies towards her, often leaving his territory, alights close beside her, and gives an intense wing-beating display during which he moves along the grass stem towards her. Most of these displays occur on tall grass stems overhanging water which usually bend to a horizontal position under the weight of the performing birds . . . . The female crouches, somewhat sleeked but otherwise appearing unconcerned, until the male is very close to her. She then either hops a short distance away, flies a short distance, or pecks fiercely at her suitor '.

During the field work I had many opportunities to study this particular phase of the breeding cycle of the Blackthroated Baya and the following account is based upon the field observations made in 1962 and 1968.

Courtship occurs at the ' helmet ' stage of the nest. It has been observed that the male adds mud blobs inside the corner of the ' helmet ' or all along the inner margin of the ' nape ' section which will later develop into the egg-chamber of the nest. He collects fresh mud blobs from nearby wet ground, or sometimes even cow-dung or human faeces, and sticks them to the wall within the ' helmet '. On 24 August 1968 I saw a male with a helmet stage nest in a mixed colony of *P. benghalensis* and *P. manyar*. A female approached quietly to inspect the nest. The male immediately started to quiver his wings and uttered feeble call notes which could be hardly heard from a distance. As the female sat on a nearby twig he approached her very closely almost touching her belly with his bent head, wings quivering, tail fanned, beak pointed to the ground presenting his brilliant yellow crown to the female. A few minutes later, he flew to a nearby tree (*Lagerstroemia*) and plucked a flower petal with his beak. Keeping the petal in his beak he came back and resumed the Wing-beating Display with head straight and bill directed towards the female, as if presenting the flower petal to her. Later he entered the helmet nest and stuck the flower petal in the wet mud blobs. He repeated the process several times, adding petal after petal in the mud blobs so that the helmet soon had a beautiful orange, crimson and scarlet coloured rim. Most often he collected yellow or orange coloured petals from *Lantana* and other wild flowers. The female entered the nest and started to remove the decoration of the nest, including the mud-blobs. Usually copulation took place at this stage. Thereafter the male continued with his nest building, and the female duly laid the eggs.

It was observed that another male who also had a helmet stage nest in the colony, constantly stole the flower petals from the first nest to stick them in his own. Actually the pilfering of flower petals from each other's nests was a common occurrence in the colony.

Baker (1934) has recorded flower petals in nests of *P. manyar*, but there is no record of their being found in the nests of *P. philippinus* or *P. megarhynchus* although mud-blobs are common to all the four Indian species of *Ploceus*.

OBSERVED CASE OF CROSS-MATING

Crook (1963) mentioned a case in which a male *P. benghalensis* attempted to copulate with a female of *P. manyar*.

On 3rd August 1961, while watching a mixed colony of Blackthroated and Streaked Weavers on the outskirts of Rudrapur, I noticed a ' helmet ' stage nest of *P. benghalensis*. The male was chasing a female of his own species and trying to attract her back again to his nest, evidently the behaviour prior to copulation. The female returned and sat on the ' cross-bar ' and started to shape the nest. The male attended her for a while and then left the colony either to fetch nesting material or food or flower petals. While shaping the nest, the female with fluffed feathers, solicited by quivering her wings. Thereupon a male *P. manyar* who was nearby promptly mounted her. The female flew off and was chased by the *manyar*. Whether coition was completed or not, the point to note here is the response given by the male *P. manyar* to the behaviour of the female *P. benghalensis* and vice versa, which implies a certain looseness in the reproductive isolation mechanism between the two species and suggests the possibility of natural hybridization. No definite instance of this has yet come to light, although a hybrid has been reported between *P. philippinus* and *P. manyar* (Gray 1958).

NESTING SUCCESS

The hatching and nesting success was 76·7% and 50·0% respectively.

NEST COMPETITORS AND PREDATORS

During the investigation, several cases of breeding of the Tree Mouse (*Vandeleuria oleracea*) in the nests of *P. benghalensis* were observed. A noteworthy observation was on 19th September, 1962, in a colony near the Rudrapur-Bilaspur road. A male was apparently fiercely defending his nest from other males, keeping them off from its proximity. His behaviour seemed curious so I approached the nest carefully, and as I touched it, a Tree Mouse jumped out and disappeared into the grass. Upon examination I found a ball of grass within—the normal nest of this rodent.

Often egg-chambers of nests were bored with holes, possibly an act of this nocturnal mammal. A Common Mongoose (*Herpestes edwardsi*) was observed feeding on the young of *P. benghalensis* in the campus of U.P. Agricultural University, Pantnagar.

Streaked Weaver

Ploceus manyar flaviceps

(Plate II)

GEOGRAPHICAL DISTRIBUTION

Two subspecies are known to occur in India (Ripley 1961) : *Ploceus manyar flaviceps* extends from Pakistan through the Himalayan terai and peninsular India to Ceylon, and *P. m. peguensis* occurs in eastern Bihar, West Bengal, Bangladesh and Assam. In the Kumaon terai all the four Indian Weavers, namely *Ploceus philippinus*, *P. megarhynchus*, *P. benghalensis* and *P. manyar* breed under more or less similar ecological conditions. The weaver birds in this area provide an unique opportunity for studying isolating mechanisms in the reproductive behaviour of these closely related species.

ECOLOGY

The Streaked Weaver inhabits swampy and rain flooded areas, particularly where tall grasses and reeds (*Phragmites*) and bulrushes (*Typha*) abound. The breeding colonies studied were situated in tall reeds standing in water and on the border of paddy fields, rain-water ditches and river banks. However, whereas the Blackthroated Weaver in the same habitat is closely addicted to thatching grass, e.g. *Saccharum munja*, this species is extremely partial to bulrushes (*Typha*) for nesting. Many colonies were also observed along the main highways, for instance between Pantnagar and Rudrapur and between Rudrapur and Gadharpur. Hume (1890) reported that the species had been seen breeding in thorny bushes, but in the study area I did not come across any such colonies. Mixed colonies of *P. manyar* and *P. megarhynchus* (Ambedkar 1968) and *P. manyar* and *P. benghalensis* in reeds are not uncommon in the terai.

Most of the breeding colonies were away from human habitation or on the outskirts of villages, but sometimes the birds did breed in more urban surroundings as in gardens near houses. For instance, in 1968 a mixed colony of *P. benghalensis* and *P. manyar* was located in the compound of the Guest House at U.P. Agricultural University. It was situated among reeds surrounding a ditch. Usually the colonies were small consisting of about 12-20 nests, but the largest colony of 60 nests was seen on the outskirts at Gadharpur village. No breeding colony of *P. manyar* was seen in the wooded part of Lalkua, suggesting that this species also requires open grassland and reed-beds.

NEST-BUILDING

The breeding season commences after the onset of the SW. monsoon, which usually starts in June and ends in September. As in the common Baya the male alone builds the nest. When the reeds are about three to four feet high, he takes up a territory and commences to build. The general architecture of the nest and the different stages of its construction are remarkably similar to those observed in the Baya (*Ploceus philippinus*) (Ali 1931, Ambedkar 1964), and also in the Blackthroated Weaver (above).

The tips of bulrushes (*Typha*) growing some distance apart are pulled in by the male and bent inwards, like the ribs of an umbrella, and bound together at the centre where they meet. This is the suspension point of the nest (Pl. II, a, b). Thus the nest is situated at the centre of an elastic framework of reeds which keeps the structure well above the water level. As the water level falls the reeds, along with the nest, slowly bend lower. This lowering of the reeds protects the nest and its contents, especially eggs, from high winds. For the construction of the nest the male collects fresh flexible green strips of *Typha* which are readily available at hand, and therefore he is able to construct two or three nests in quick succession. Unlike the Baya, the Streaked Weaver collects only a single broad and rather thick bulrush strip at a time. Holding the strip in the bill the bird springs up towards the free end of a *Typha* leaf. After gripping it in his bill he flutters back to the nest bending the leaf down with his weight thus incorporating the leaves one by one in the nest structure and securing each firmly with the strips he has brought in his bill. As soon as the nest reaches the ' helmet ' stage, the male adds mud-blobs or plasters the lower portion of the nest (Pl. II, c). Frequently, but not as regularly as in the Blackthroated Weaver (*Ploceus benghalensis*), he also sticks brightly coloured flower petals in the mud-blobs. Baker (1934) has also reported seeing flower petals in the nests of the Streaked Weaver. It has been suggested above in the case of the Blackthroated species, that the flower petals are used in courtship to attract a female. The courtship takes place at the ' helmet ' stage of the nest.

One of my field notes on courtship reads as follows: 'Today (23 Sept. 1962) the sky is clear with bright sunshine after two days of heavy showers with gusty winds. I visited the colony at Jafarpur canal and noticed considerable nesting activity. All the nests had reached the "helmet" stage. The males were singing, and the visiting females were greeted with bursts of song and quivering and spreading wings. The females were prospecting for suitable nests, visiting and inspecting them one after another. When a female sat on a particular nest, the owner greeted her with song and with the "Wing-beating Display". If the female left the nest, the owner followed her awhile. As soon as the female left the colony, the male returned and sat on the nest. He collected nesting materials from bulrushes and added them into the nest structure. If a female flew over the colony all the building males suddenly burst into song and vigorously attended to their nests. If a female accepted a particular "helmet" stage nest, copulation took place on the cross-bar of the nest.'

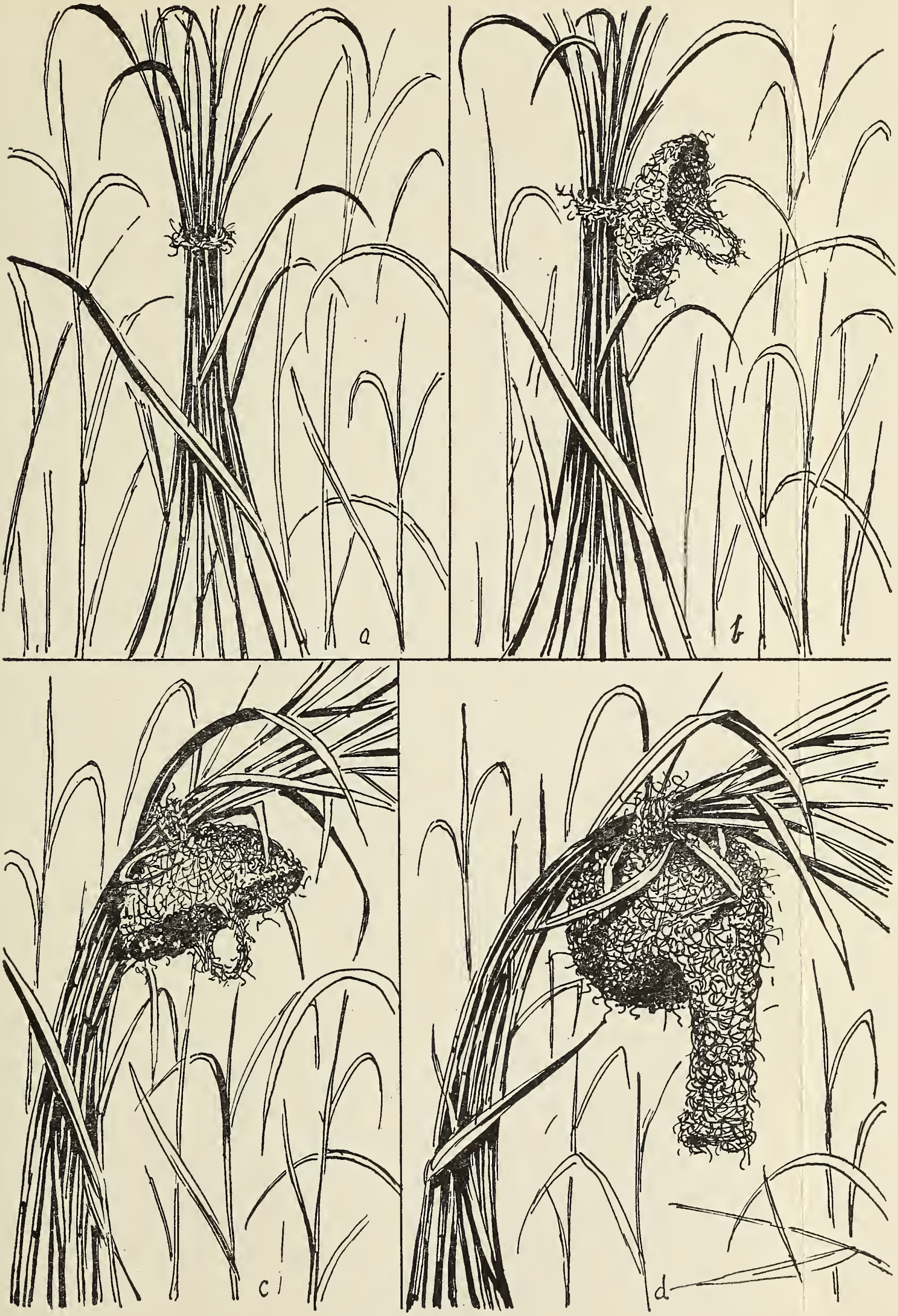
The eggs are laid about three or four days after copulation. Once the nest is completed the male usually pays little attention to its maintenance, with the result that the structure looks bedraggled with loose fibres hanging about. The entrance tube is short as compared with the nest of the Baya and the Blackthroated Weaver. Thus the nest has the shape of a retort with entrance from below (Pl. II, d).

Mixed colonies of *P. manyar* and *P. benghalensis* where the birds are breeding side by side, provide interesting material for comparative study. *P. benghalensis* selects the denser parts of the reed patch (mostly *Saccharum munja*) as the species requires a larger number of grass blades for the support of its nest. I counted (30 Sept. 1961) the number of supporting reeds which are respectively incorporated in the nest of *P. benghalensis* and *P. manyar*. The former collected 78 (average) blades of *Saccharum* as against 32 *Typha* blades in the latter. Usually the nests of *P. benghalensis* are built in clusters of three or four nests whereas the nests of *P. manyar* are scattered individually in the same *Typha* bed.

P. manyar is polygynous. Crook (1963) described monogamy in the terai, while Sálim Ali suggested that the species is polygynous. My observations made in 1968 confirm the latter view. One male completed three nests in succession which were duly occupied by females, in addition to a fourth nest left unfinished at the 'helmet' stage.

CLUTCH SIZE

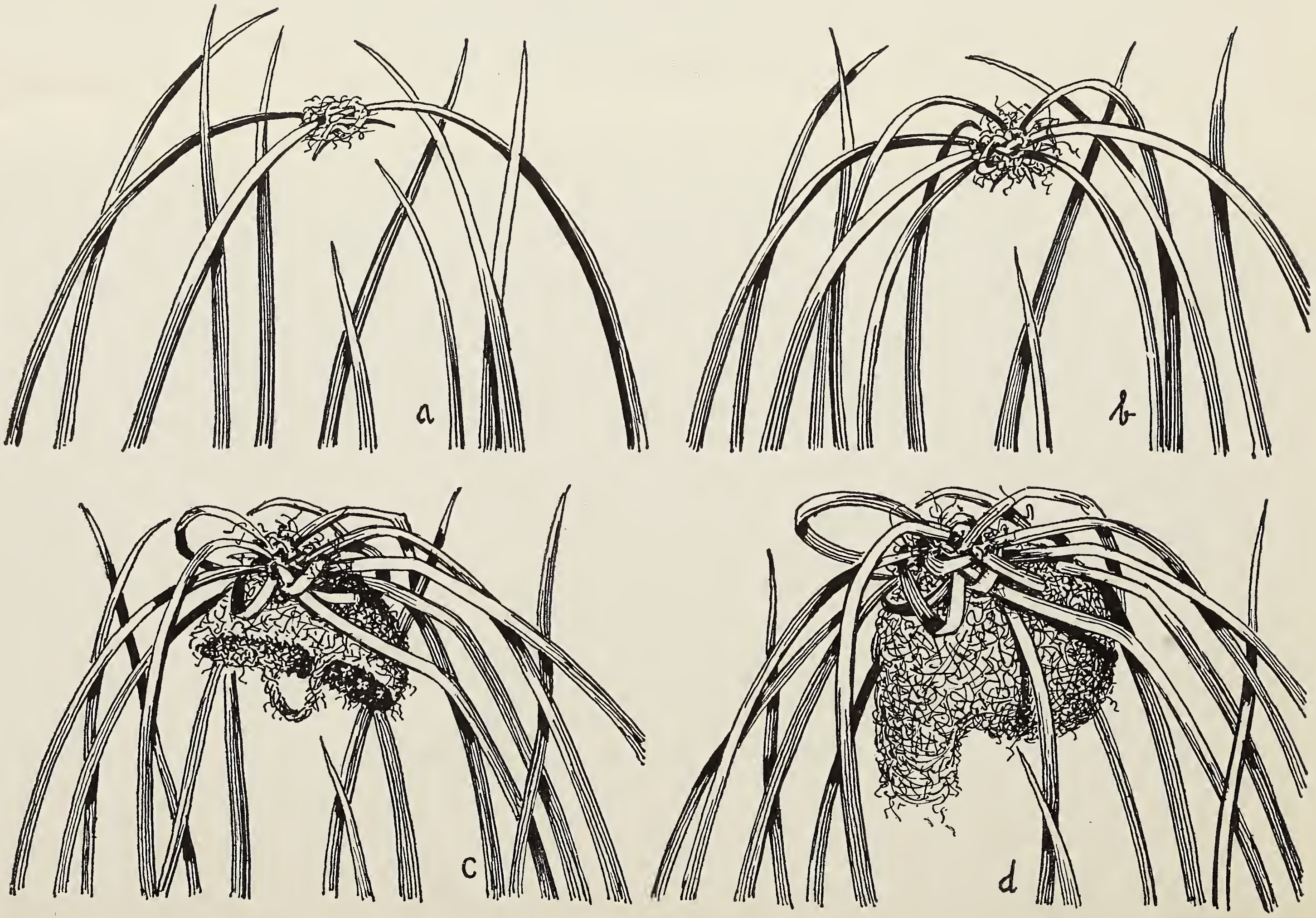
Table 5 shows the average clutch-sizes of the Streaked Weaver for the years 1959, 1961, 1962 and 1968. Data collected by Sálim Ali & Crook in the year 1959(*) are included. The average clutch-sizes were 2·8, 2·4, 3·2 and 3·1 respectively, while the overall clutch-size for the four



Ploceus benghalensis

Stages of nest construction among thatching grass (*Saccharum* sp.)

(*a*) The initial 'waist' belt (*b*) A further stage in the attachment; (*c*) The helmet stage showing mud plastering along edge of nape portion, with flowers implanted; (*d*) The completed nest.



Ploceus manyar

Stages of nest construction among bulrush leaves (*Typha* sp.)

(*a*) The initial 'wad'; (*b*) A further stage in th[illegible] [illegible] (*c*) The '[illegible]' stage, showing mud plas[illegible] along [illegible] edge of '[illegible]' portion, with flowers implanted; (*d*) The completed ne[illegible] years was 3·0. Table 1 thus shows that 3 is the commonest clutch-size in this Weaver in the Kumaon terai ; out of 84 clutches, 44 or 52·3% belong to this size group.

TABLE 5

EGGS PER CLUTCH/NO. OF CLUTCHES

Year	1	2	3	4	5	6	Total	Mean eggs per clutch
1959*	..	2	4	1	..	..	7	2·8
1961	2	2	6	..	..	..	10	2·4
1962	1	6	20	8	2	1	38	3·2
1968	2	4	14	6	3	..	29	3·1
Total	5	14	44	15	5	1	84	3·0

EGG WEIGHT

The eggs are white in colour as in other Indian weavers. They are laid mostly early in the morning. Weights were taken as soon as the eggs were found in the nests. The average weight of the fresh egg was 2·3 gm (36 observations) : maximum 2·7 gm, minimum 2·0 gm (see Table 6).

TABLE 6

WEIGHTS OF FRESH EGGS

No. of observations	1	6	4	6	5	5	8	1	36
Grammes	2·0	2·1	2·2	2·3	2·4	2·5	2·6	2·7	

INCUBATION

This is the most interesting part of the breeding cycle in the case of *P. manyar*, as it shows a marked deviation from the general pattern observed in other Indian weavers. In other Indian weavers the female is solely responsible for the incubation of the eggs. However, in the Streaked Weaver the male also takes a little part in this chore, at least for the first or second day, when the female is still laying. One of my field notes reads :

'29-viii-1962 while I was observing a nest of the Streaked Weaver in a *Typha* reed-bed, a female went out of the nest probably for foraging. The male was singing, standing on the top of the nest. After a while he quietly entered the nest and sat on the eggs for eight minutes. He came out as soon as the female returned. There was only one egg in the nest'.

A similar incident was observed on 22nd September 1962, and again in the 1968 breeding season suggesting that incubation by the male is a common feature in the Streaked Weaver. In all these instances, there was only one egg in the nest. Crook (1963) mentions two cases where males were seen incubating eggs ; no details are given.

The female usually starts to incubate regularly from the second egg ; the male continues to construct the tube of the nest.

Table 7 shows the period of incubation to be 14 to 17 days.

TABLE 7
INCUBATION PERIOD

No. of days	No. of clutches observed
14	2
15	8
16	6
17	5

During the day the movements of the females are very irregular. They usually sit on the eggs for a few minutes and come out of the nests again either for bathing or feeding. It is assumed that these restless movements are attributable to heat and the high atmospheric temperature. Incubation is continuous during the night, the females entering the nests about sunset and emerging before sunrise.

NESTLING PERIOD

Usually the female broods the nestlings from the first day of hatching till the young are about a week old. During this period she is solely responsible for feeding the young. However, when the young are about 10 days old the male also starts to feed them. The food is usually collected from nearby rice fields and consists mainly of small insects, soft grains and grass seeds, etc.

TABLE 8
NESTLING PERIOD

No. of days	No. of young flew
15	1
16	2
17	6
18	5
19	2
20	1

Average period in nest = *c*. 17 days.

NESTING SUCCESS

Hatching and nesting success were worked out as follows: In all 70 eggs were under observation, of which 51 eggs hatched (72·8%) and 45 young flew successfully (64·2%).

In the terai region, the commonest competitor of the Streaked Weaver is the Longtailed Tree Mouse (*Vandeleuria oleracea*), who builds his own nest in that of the weaver, most probably after destroying the eggs. This rodent is also known to nest in other weaver nests namely the Baya (*Ploceus philippinus*) and the Blackthroated Weaver (*Ploceus benghalensis*).

On 26th September 1962, I saw a Pied Crested Cuckoo alighting on the top of a nest. The presence of the cuckoo agitated the weavers. The males tried to drive it away but there was no actual attack on the bird. The cuckoo left the colony after about five minutes without any attempt to tamper with the nests.

A pair of Whitebacked Munia inspected a nest containing young in the absence of the owner (25 August 1968). Both the munias entered the nest and spent 3-4 minutes inside.

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Orchids of Nepal—6

BY

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(*With five text-figures*)

[*Continued from Vol.* **68** (3) : 665]

The genera that are placed under the series *Pleuranthae*—subseries *Sympodiales* by Schultes & Pease (1963) are treated in this paper which is the sixth of the series on Nepal Orchids. The genera dealt with are *Cremastra* and *Oreorchis* (subtribe Cryptoideae), *Cymbidium* (subtribe Cymbidieae), *Anthogonium*, *Calanthe*, *Pachystoma* and *Spathoglottis* (subtribe Phajeae) ; however the genera are arranged alphabetically.

ARTIFICIAL KEY TO THE GENERA

A. Inflorescence terminal ; pollinia without appendage :
  B. Pollinia 8 ; sepals free :
    C. Nodose rhizome. Flowers hairy, small *c.* 1·25 cm in diam. ; sepals conniving ; column elongate produced into a foot ; lip 3-lobed, disk with fimbriate ridges ...... *Pachystoma*
    CC. Creeping rhizome bearing pseudobulbs. Flowers *c.* 2·5 - 3·8 cm in diam. ; sepals spreading, column elongate, foot absent ; lip 3-lobed, disk pubescent .... *Spathoglottis*
  BB. Pollinia 4 ; terrestrial :
    C′. Sepals connate into a cylindrical tube ; petals linear, claws free within the sepals ; column elongate, foot absent. Flowers on a leafless lateral raceme.................... *Anthogonium*
    C′C′. Sepals and petals distinct, suberect ; column long. Terrestrial with 1 leaf.................................. *Oreorchis*

AA. Inflorescence terminal ; pollinia appendaged :
  B′. Lip spurred, claw connate into a tube with the column, bases of pollinia long resembling caudicles. Terrestrial with plicate leaves ...... *Calanthe*
  B′B′. Lip not spurred nor conspicuously saccate ; column not produced into a foot ; sepals petals subequal, spreading ; lobes of lip embracing the unwinged column....................... *Cymbidium*
  B′B′B′. Sepals, petals and lip very narrow and conniving in a tube. Scape leafless ; flowers in a raceme......................... *Cremastra*

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Anthogonium Lindl.

According to Schultes & Pease, the name refers probably to the curious angle at which the tubular flower is joined to the pedicellate ovary.

Anthogonium gracile Lindl. Gen. et Spec. Orch. 426, 1840 ; F.B.I. 5 : 822, 1890 ; King & Pantl. 96, t. 134, 1894 ; Hara, 425, 1966. (Fig. 1).

Terrestrial slender orchid with small pseudobulbs ; inflorescence a simple or branched raceme. Flowers resupinate i.e. labellum posterior due to the torsion of the flower, pink ; sepals united to form a tubular structure with tips free, short ; petals included, linear, long clawed. Lip adnate to the base of the column, long clawed, limb recurved, obscurely lobed, spotted red. Flowering during August and September. Distributed between 1220 to 1830 m. Collected from Dolaghat to Chaubas, Sundarijal, Buludanda and Sheopuri.

Calanthe R. Br.

The name alludes to the beautiful flowers of most of the species. These are terrestrial with pseudobulbs and bear sizable distinctly folded leaves. The inflorescence is either erect or arching.

ARTIFICIAL KEY TO THE SPECIES OF *Calanthe*

A. Spur absent : flowers *c.* 1·8 cm in diam. ; lip brown-purple with 3 large fleshy ridges .... *tricarinata*
AA. Spur present ; flowers large—*c.* 3 cm or more in diam.
    B. Petals narrow ; lip longer than the sepals—
        C. Lip with 3 basal lamellae .... *plantaginea*
        CC. Lip without lamellae .... *chloroleuca*
    BB. Petals broad ; lip hardly exceeding the sepals .... *masuca*

Calanthe chloroleuca Lindl. Fol. Orch. 10, 1828-29 ; F.B.I. 5 : 852, 1890 ; King & Pantl. 231, 1898 ; Hara, 428, 1966.

Scape stout, bracts very small. Sepals ovate-lanceolate, greenish, streaked with 3 red nerves ; petals lanceolate, 3-nerved, yellowish. Lip white, sidelobes small, rounded and folded on the middle lobe, midlobe obcordate, bilobed ; spur stout, longer than the sepals, puberulous. Authority Hara.

C. masuca (Don) Lindl. Gen. et Spec. Orch. 249, 1840 ; F.B.I. 5 : 851, 1890. *Bletia masuca* D. Don, Prodr. Fl. Nep. 30, 1825.

Terrestrial ; flowers pale or dark purple. Sepals *c.* 2 cm long, lanceolate, acuminate, 5-nerved ; petals obovate or broadly oblong 3-5-nerved. Lip exceeding the sepals *c.* 2·25 cm long, calli yellow, sidelobes falcate, oblong, midlobe much longer, broadly reniform, widened to *c.* 1·5 cm.

spur longer than the sepals. Flowering from July to September. Distributed at 1220 to 1980 m. Collected from Kakni hills, Brajrabarahi.

C. plantaginea Lindl. Gen. et Spec. Orch. 250, 1840 ; F.B.I. 5 : 853, 1890 ; Duthie, Orch. North-West. Himal. 122, 1906. (Fig. 2).

Flowers pale lilac ; sepals ovate-lanceolate, 3-5-nerved ; petals oblanceolate, acuminate, 3-nerved. Lip longer than the sepals with 3 small basal lamellae, sidelobes cuneate-obovate, midlobe with 3 small ridges near the base, subtruncate, apiculate, spur longer than the sepals. Flowering during March and April. Distributed at 2135 to 2440 m. Collected from Papung to Topkegola, Godavari, locality unknown (Herklotts).

C. tricarinata Lindl. Gen. et Spec. Orch. 18, 1840 ; F.B.I. 5 : 847, 1890 ; Duthie, Orch. North-West. Himal. 119, 1906. (Fig. 3).

Scape stout ; flowers greenish-red ; sepals lanceolate, acuminate, 7-nerved ; petals nearly as broad, acuminate, both green outside and whitish along the margins, 3-nerved. Lip sessile, brownish-purple, disk with 3 large crenulate ridges ; spur absent. Flowering during April and May. Collected from Ghorepani forest (Thakkhola area), Naukhola, locality unknown (Herklotts).

Cremastra Lindl.

The generic name refers to the pedicellate ovary. They are terrestrial orchids and are small and insignificant plants.

Cremastra appendiculata (D. Don) Makino, in Bot. Mag. Tokyo, 18 : 24, 1904 ; Schlecter, Orch. Sino-Japan 225, 1919 ; Hara, 429, 1966. *Cymbidium appendiculata* D. Don, Prodr. Fl. Nep. 36, 1825 ; *Cremastra wallichiana* Lindl. Gen. et Spec. Orch. 173, 1833 ; F.B.I. 6 : 16, 1890 ; King & Pantl. 182, t. 246, 1898.

Terrestrial with a solitary leaf and the flowering scape about 50 cm long. Flowers purple *c.* 3·8 cm in diam., sepals and petals very long, narrow, conniving into a tube below, lanceolate, acuminate and spreading, recurved above. Lip adnate to the base of the column, erect, linear, base saccate, tip dilated and 3-lobed, lobes linear ; column long and straight with top dilated and 3-lobed. Flowering during June. Collected from Hongaon to Sempung at *c.* 1980 m.

Cymbidium Sw.

The name alludes to the boat-shaped lip. These are mostly epiphytic but some are terrestrial as well. Leaves are usually very long, narrow and coriaceous. Inflorescence is pendulous, arching or erect. Floral shape is diversified so also is the coloration.

Artificial key to the species of *Cymbidium*

A. Labellum broad, rostellum usually not beaked—
B. Leaves elliptic-lanceolate, 15-25 cm long; scape shorter than the leaves, few-flowered; fls. *c.* 3·5 cm in diam. .... *lancefolium*
BB. Leaves very long, tips usually lobed; scape many-flowered; fls. *c.* 3·5 cm in diam. .... *simulans*
BBB. Leaves linear or linear-lanceolate—
C. Flowers *c.* 5 - 6 cm in diam.
D. Bracts large, equalling or exceeding the ovary; leaves 60 - 95 cm long .... *cyperifolium*
DD. Bracts small—
E. Lip pubescent; leaves *c.* 65 - 75 cm by 1·5-2 cm., not notched; fls. 3·5 - 5 cm in diam .... *pendulum*
EE. Lip pubescent and ciliate all over; leaves *c.* 30 - 65 cm by 2 - 4 cm; fls. *c.* 5 - 6 cm in diam. .... *giganteum*
EEE. Lip papillose within and not ciliate; leaves *c.* 60 - 95 cm by 1 - 2 cm; fls. *c.* 5 - 6 cm in diam. .... *longifolium*
CC. Flowers *c.* 8 - 10 cm in diam.; long fimbriate hairs on the margin of the lip .... *grandiflorum*
AA. Labellum narrow; rostellum beaked; bracts small .... *elegans*

Cymbidium cyperifolium Wall. ex Hk. f. in Fl. Brit. Ind. 6 : 13, 1890.

Epiphytic; flowers greenish and fragrant; sepals and petals linear-lanceolate, acute pale green and yellow streaked with red; lip narrow, glabrous, greenish or greenish-white, spotted red. Flowering during March and April. Collected from Godavari top at *c.* 2135 m.

C. elegans Lindl. Gen. et Spec. Orch. 163, 1833; Hara 430, 1966. *Cyperorchis elegans* Bl. Rumphia 4 : 47, 1836; F.B.I. 6 : 14, 1890; King & Pantl. 159, t. 259, 1898.

Epiphytic. Flowers white or pale yellow, sepals and petals linear-oblong, acute, tips recurved. Lip as long as the petals, slightly recurved, sparsely hairy towards the base, central ridges terminating below in 2 long pubescent calli, hypochile narrowly cuneate, sidelobes spreading but apically incurved, obtuse nearly as long as the midlobe, midlobe suborbicular, margin undulate. Flowering from September to November. Distributed at 1825 to 2135 m. Collected from Sheopuri and Kakni.

C. giganteum Wall. ex Lindl. Gen. et Spec. Orch. 163, 1833 : F.B.I. 6 : 12, 1890.

Epiphytic, inflorescence longer than the leaves. Flowers smaller than *C. grandiflorum*, *c.* 5-6 cm in diam. ; floral bracts minute ; sepals and petals oblong-lanceolate, acute, green streaked with purple all over, midlobe large, orbicular. Flowering during September and October. Distributed between 1220-1525 m. Collected from Godavari, Sundarijal, Nall near Banepa.

C. grandiflorum Griff. Icon. Pl. Asiat. t. 321, 1874 ; F.B.I. 6 : 12, 1890 ; King & Pantl. 192, t. 256, 1896 ; Hara 430, 1966. (Fig. 4).

Epiphytic. Flowers sweet smelling, *c.* 10 cm in diam., sepals and petals oblong-lanceolate, acute, green, dorsal sepal incurved lateral sepals recurved. Lip yellowish, pubescent and ciliate, midlobe large, suborbicular, waved and crenulate, speckled with purple spots, two hairy ridges on the disk between the sidelobes. Flowering during May and June. Distributed between 1525 to 2300 m. Collected from Rhingmo to Jubing, Bokejunde near Trisuli, Bhojpur.

The presence of long fimbriate hairs on the margin of the lip is a very characteristic feature of this species.

C. lancefolium Hook. Exot. Fl. t. 51, 1828 ; F.B.I. 6 : 9, 1890. (Fig. 5)

Epiphytic ; scape erect and usually shorter than the leaves. Flowers fragrant ; *c.* 3·5 cm ; sepals yellowish or pale green, lanceolate, acuminate ; petals rather broader, white or paler, with a pink midrib. Lip white and spotted purple, sidelobes narrow and rounded, midlobe ovate, obtuse, slightly curved downwards, 2 median lamellae between the sidelobes, column greenish with purple markings. Flowering during June to August. Distributed at 1220 to 1525 m. Collected from Sheopuri, Sundarijal, Nagarjung, locality unknown (Herklotts).

C. longifolium D. Don, Prodr. Fl. Nep. 36, 1825 ; Lindl. Gen. et Spec. Orch. 163, 1833 ; F.B.I. 6 : 13, 1890 ; King & Pantl. 196, t. 254, 1894 ; Hara 430, 1966 ; *Cymbidium erythraeum* Lindl. Journ. Linn. Soc. 3 : 30, 1859.

Epiphytic ; with the inflorescence curved in the upper part. Flowers smaller than that of *C. giganteum*, *c.* 5-6 cm. in diam., mildly scented, floral bracts minute. Sepals and petals linear-oblong or even lanceolate, acute, greenish and streaked with red or purplish lines. Lip papillose within not ciliate ; midlobe broadly ovate or orbicular, white and spotted with red. Flowering from late September to November. Distributed at 1830 m. Collected from Sheopuri above Tokha.

The smaller sized flowers and the absence of marginal fimbriate hairs on the lip are characteristic features.

C. pendulum (Roxb.) Sw. in Nov. Act. Soc. Sci. Upsal. 6 : 73, 1799 ; King & Pantl. 188, t. 251, 1898 ; Duthie, Orch. North-West. Himal.

136, 1906 ; Hara, 431, 1966 ; *Epidendrum pendulum* Roxb. Pl. Corm. 1 : 35, t. 44, 1795 ; *Cymbidium aloifolium* Lodd. Bot. Cat. 10, t. 967, 1825 non Swartz, F.B.I. 6 : 10, 1890 (pp).

Epiphytic with inflorescence decurved from base, and covered by many imbricate sheaths, shorter than leaves. Flowers not crowded, light yellow, *c.* 3·5-5 cm in diam., floral bracts minute. Sepals slightly dilated near their apices, oblong, petals as long as sepals, margins yellow. Lip oblong, dilated and sub-saccate at base, midlobe blunt, emarginate, decurved, side-lobes with blunt apices and erect, disk with two lamellae which are divergent at the base. Flowering during May to July. Distributed at 305 to 915 m. Collected from Hittaura and Dhankutta.

C. pendulum Sw. and *C. aloifolium* Sw. are distinct species and the differences have been shown by King & Pantl. Similarly *C. simulans* is also confused with *C. aloifolium* Sw. and this has been clarified by Cooper (Dist. Gard. 2 : 610, 1915).

C. simulans Rolfe, in Orch. Rev. 25 : 175, 1917 ; Holttum, 519, 1953 ; Hara, 413, 1966 ; *C. aloifolium* Sw., sensu Hk. f. in F.B.I. 6 : 10, 1890 ; King & Pantl. 189, t. 252, 1898.

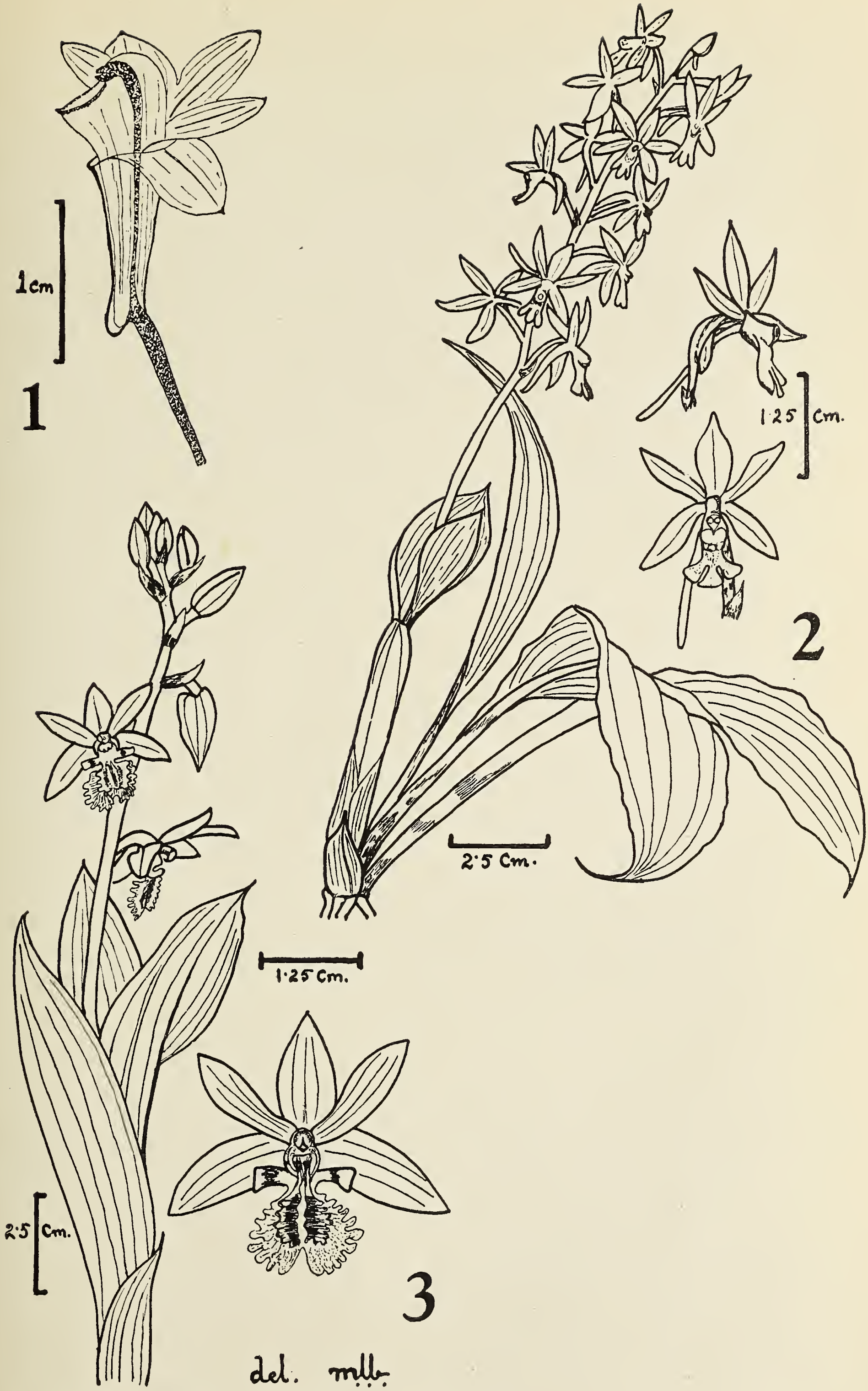
Epiphytic with inflorescence usually 25 cm. long and pendulous. Flowers variable in colour and size, usually dull purplish-brown with pale borders, *c.* 3·5 cm in diam. ; sepals and petals linear-oblong, subacute. Epichile broadly oblong and equalling the hypochile, disc with two curved thick lamellae. Flowering during May and June. Distributed in the tropical region, particularly in the terai at 300 to 915 m. Collected from Dingla Khandbari, Hittaura, Dhunibesi, Dhaitarbesi.

Oreorchis Lindl.

Terrestrial and saprophytic orchids with 1 or 2 leaves which are narrow. Flowering stem erect with small flowers.

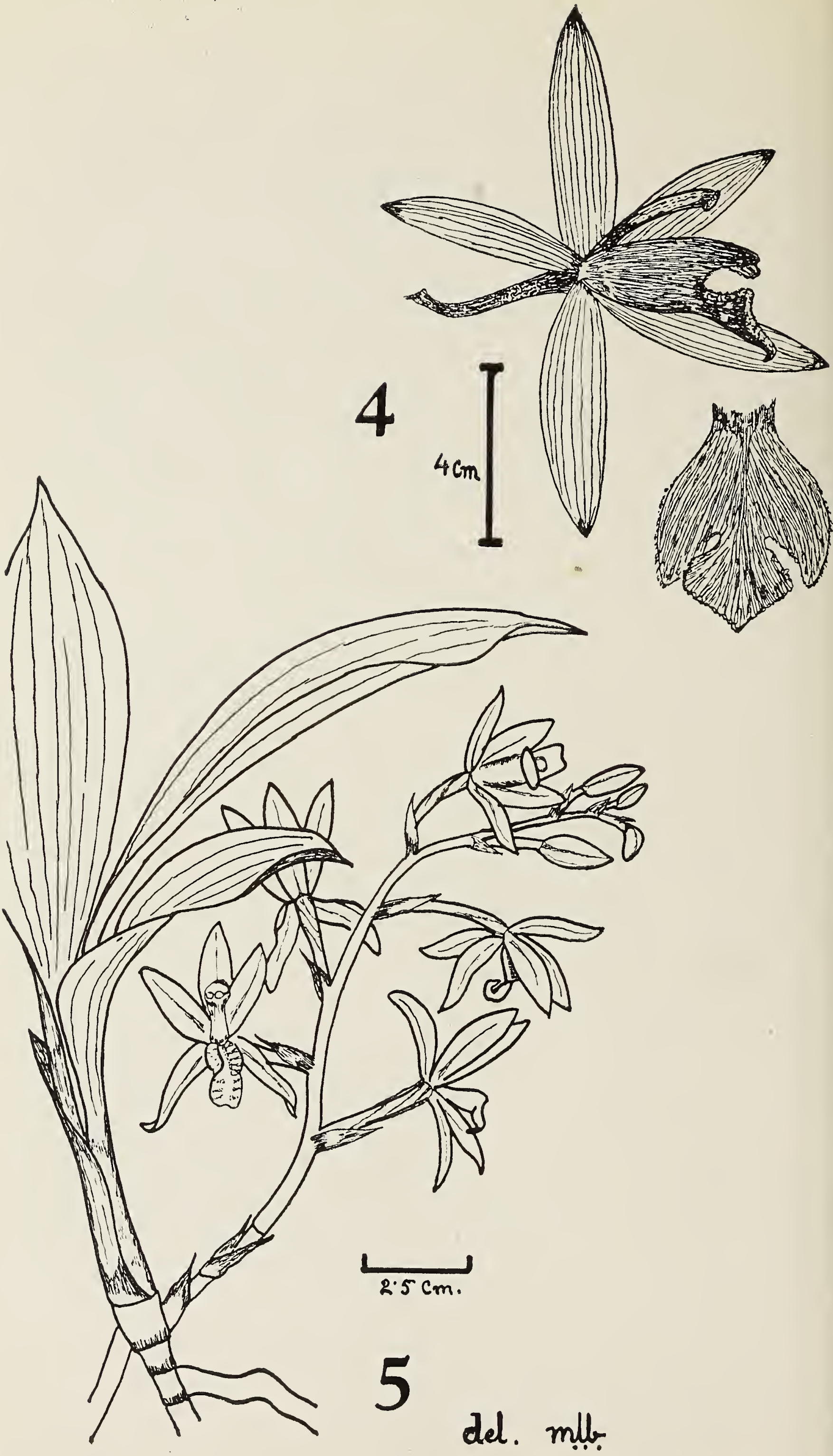
Oreorchis foliosa (Lindl.) Lindl. Journ. Linn. Soc. 3 : 27, 1859; F.B.I. 5 : 709, 1890 ; King & Pantl. 183, t. 137, 1898 ; Duthie, Orch. North-West. Himal. 131, 1906 ; Hara, 446, 1966 ; *Corallorhiza foliosa* Lindl. Gen. et Spec. Orch. 535, 1840.

Leaf solitary, oblong-lanceolate and with prominent nerves. Flowers red or reddish *c.* 1 cm in diam., dorsal sepal linear-oblong, subacute, straight, lateral sepals falcately oblong, acuminate ; petals broadly oblong, obtuse. Lip many-nerved, base produced into a sac, lateral lobes erect, rounded and short, midlobe as large as both the side lobes, notched. (Flowering during July). Collected from Bangukhola, Sama (Kitamura).



1cm
1
1·25 Cm.
2·5 Cm.
2
1·25 Cm.
2·5 Cm.
3
del. mlb.

Figs. 1. Flower of *Anthogonium gracile* Lindl.
2. *Calanthe plantaginea* Lindl. ; 3. *C. tricarinata* Lindl.


4
4 Cm
2·5 Cm.
5
del. mlb.

Figs. 4. Flower of *Cymbidium grandiflorum* Griff. (parts slightly displaced); 5. *C. lancefolium* Hook.

Pachystoma Bl.

Terrestrial orchids with thick rhizome. Leaf solitary or in pairs and appearing after the flowers. Inflorescence is crowded with small flowers that are tinted pink. The apex of the lip is thick.

Pachystoma senile (Lindl.) Reichb. f. in Boplandia, 3 : 250, 1858 ; F.B.I. 5 : 812, 1890 ; King & Pantl. 101, t. 140, 1898 ; Duthie, Orch. North-West. Himal. 108, 1906 ; *Apaturia senilis* Lindl. Gen. et Spec. Orch. 130, 1831.

Terrestrial orchid with usually a solitary leaf. Flowers white or greenish-white and tinted pink, glandular, puberulous ; sepals *c.* 1 cm long, membraneous, acute 5-nerved, lateral sepals adnate to the base of the column. Lip greenish-yellow, sessile on the base of the column, erect, side lobes oblong, midlobe small and turned downwards, disk with 5 fimbriate ridges from the base to the midlobe and then thickened. (Flowering in April and May). Authority Parker.

Spathoglottis Bl.

Orchids with creeping rhizome from which pseudobulbs arise. According to Hawkes the structure of the blossoms is a characteristic one, not to be readily confused with any of the related genera. The lip is strongly 3-lobed and the column is winged.

Spathoglottis ixioides (D. Don) Lindl. Gen. et Spec. Orch. 120, 1831 ; F.B.I. 5 : 814, 1890 ; *Cymbidium ixioides* D. Don., Prodr. Fl. Nep. 36, 1825.

Creeping terrestrial orchid with a scape *c.* 10-15 cm long. Flowers yellow, *c.* 3-3·5 cm in diam., sepals and petals about equal, sepals hairy, spreading. Lip 3-lobed, midlobe of sub saccate lip cuneate or obcordate with an auricle on each side at its base, side lobes very broad, oblong disk pubescent. Collected from Gumurang to Sarti (Kitamura).

(*to be continued*)

Some observations on the Fauna of the Maldive Islands (Indian Ocean)
Part VIII. Marine Shells

BY

K. R. SMYTHE AND W. W. A. PHILLIPS

INTRODUCTION

Although the Marine Shells, comprising this small collection, were brought to England as long ago as 1957 and 1959, it is only recently that they have been critically examined and identified by Mrs. Smythe. They were collected, chiefly by Mrs. Paddy Phillips, in Male Atoll (1956/57) and in Addu Atoll (1958/59). Owing to other, more pressing, commitments, no efforts were made to make thoroughly representative collections but, even so, over a hundred species were obtained for the wealth of marine shells in these Islands is outstanding.

Most of the shells forming the collection were picked up, dead, on the beaches and coral reefs but some living shells were collected on the reefs at low tides and others were presented to us by the local Maldivians who are very shell-conscious.

Representative examples from the collection have been donated to the Natural History collections at the Bognor Regis Museum, in West Sussex, while others have been retained in private collections. In the following lists, the trivial (English) names have been given, where known.

For a short description of the Maldive Islands, reference may be made to Part I. ' Introduction ' of this series of papers on the Fauna of the Maldive Islands, published in this *Journal* (April 1958), Vol. **55** (1): 1-10.

MARINE SHELLS FROM THE MALDIVE ISLANDS (MALE ATOLL & ADDU ATOLL) INDIAN OCEAN, COLLECTED BY MAJOR & MRS. W. W. A. PHILLIPS

Family CYPRAEIDAE (Cowrie Shells)

Cypraea tigris Linne. = Tiger Cowrie
Pustularia globulus Linne. = Globular Cowrie
Arabica depressa Gray =
Arabica scurra Gmelin = Jester Cowrie
Arabica histrio Gmelin = Harlequin Cowrie
Evenaria asellus Linne. = Three-banded Cowrie
Evenaria hirundo Linne. = Swallow Cowrie
Ravitrona poraria Linne. =
Ravitrona caputserpentis Linne. = Snakes-Head Cowrie
Ravitrona helvola Linne. = Star Cowrie
Erosaria inocellata Gray =
Erosaria turdus Lamarck = Thrush Cowrie
Erosaria erosa Linne. = Eroded Cowrie
Lynacina lynx Linne. = Lynx Cowrie
Basilitrona isabella Linne. = Isabelle Cowrie
Ovatipsa chinensis Gmelin = Chinese Cowrie
Monetaria moneta moneta Linne. = Money Cowrie
Monetaria moneta monetoides Iredale* = Money Cowrie
Ornamentaria annulus scutellum Schilder & Schilder = Ringed Cowrie

Mauritia mauritiana Linne. = Black or Hump-back Cowrie
Talparia talpa Linne. = Mole Cowrie
Arestoides argus Linne. = Argus-eyed Cowrie
Nuclearia nucleus Linne. =
Ponda carneola Linne. = Flesh-coloured Cowrie
Palmadusta clandestina Linne. = False Three-banded Cowrie

*Some Authorities consider that the *moneta* merge ; they do not differentiate the sub-species.

Note—Cowries, of many species, would appear to be amongst the most plentiful shells in the Maldives. *Cypraea tigris*, although much sought after by the Maldivians, are commonly to be found in the pools on the coral reefs encircling the Islands, in both Male Atoll and Addu Atoll. Money Cowries were, until very recently, still used as minor currency ; they are abundant everywhere.

Family CONIDAE (Cone Shells)

Conus moreleti Crosse =
Conus eburneus Hwass =
Conus geographus Linne. = Geography Cone
Conus tessulatus Born = Tessellate Cone
Conus lividus Hwass =
Conus ebraeus Linne. = Hebrew Cone

Conus splendidulus Sowerby =
Conus arenatus Hwass =
Conus betulinus Linne. =
Conus chaldeus Röding =
Conus miles Linne. = Soldier Cone
Conus lithoglyphus Hwass =
Conus emaciatus =
Conus flavidus Lamarck = Yellow Cone
Conus omaria Hwass =
Conus fulgetrum Sowerby =
Conus nemocanus Hwass =

Many of the smaller species of Cone Shells were almost as plentiful as the smaller Cowries on the reefs and beaches in Male and Addu Atolls. Very many of them were, however, much beach-worn. The larger species were not so plentiful. The venomous species *Conus geographus* appears to be rare.

Family Tonnidae (Tun-Shells)

Tonna galea Linne. =
Tonna perdix Linne. = Partridge Tun-Shell

Family Harpidae (Harp-Shells)

Harpa major Röding =
Harpa amouretta Röding =

Family Fasciolariidae (Knobbed Chanks or Tulip Shells)

Cantharus undosus Linne. =
Paralgena smaragdula Linne. =
Latirus polygonus Gmelin =
Pleuroploca filamentosa Röding =

Family Mitridae (Mitre-Shells)

Mitra mitra Linne. = Episcopal Mitre
Mitra digitalis Dillwyn =
Mitra sp.+*Mitra* sp. =

Mitra mitra was moderately plentiful on the coral reefs of Addu Atoll.

Family Strombidae (Wing-Shells, Strombs or Spider Conch)

Lambis lambis Linne. = Five-fingered Chank, Scorpion Shell or Common Spider Conch
Lambis bryonia Gmelin = Giant Five-fingered Chank
Lambis chiragra Linne. = Chiragra Spider Conch
Strombus gibberulus Linne. = Humped Conch
Strombus mutabilis Swainson =

Whereas *Lambis lambis* was plentiful on the reefs around both Male and Addu Atolls only one specimen of *Lambis bryonia* was obtained in Male.

Family Turbinidae (Turban Shells)

Turbo petholatus Linne. = Painted Turban
Turbo intercostalis Menke = Ribbed Turban

Family Terebridae (Auger Shells)

Terebra crenulata Linne. = Crenulate Auger
Terebra dimidiata Linne. = Dimidiate Auger
Terebra subulata Linne. = Subulate Auger
Terebra maculata Linne. = Marlinspike Shell

Family Olividae (Olive Shells)

Oliva minacea Röding =

Family Thaisidae (Rock Shells)

Drupa ricina Linne. = Prickly Drupe
Drupa spathulifera Blainville =
Morula granulata Duclos =
Nassa sertum Bruguiere = Sertum Rock Shell

Family Haliotidae (Abalone Shells)

Haliotis ovina Gmelin =

Family Bursidae (Frog Shells)

Bursa livida =
Bursa rosa Perry =

Family Cymatiidae (Tritons or Triton Trumpet Shells)

Charonia tritonis Linne. = Charon's Trumpet or Pacific Triton
Cymatium lotorium Linne. = Lotorium Hairy Triton
Cymatium gemmatum Reeve = The Beaded Triton
Distorsio anus Linne. =
Lampusia nicobarica Röding =

Distorsio anus was plentiful around Dunidu Islet, close to Male, the Capital, in North Male Atoll, but was not seen elsewhere. A single large *Charonia tritonis*, about 8 inches in length, was presented to us in Gan. Addu Atoll. It appears to be scarce in the Maldives.

Family BULLIDAE (Bubble Shells)

Bulla ampulla Linne. = The Bubble Shell

Family PYRAMIDELLIDAE

Pyramidella acus Gmelin =

Family NASSARIDAE (Dog Whelks)

Nassarius sp. (possibly *crenulatus*) =

Family NERITIDAE (Nerite Snails)

Nerita polita Linne. = Polita Nerite
Nerita albicilla Linne. =
Nerita textilis Gmelin =

Family CERITHIIDAE (Horn Shells)

Cerithium nodulosum Bruguiere =
Cerithium echinatum Lamarck = Prickly Horn-Shell

Family MURICIDAE (Rock Shells)

Pterynotus triquetor Born =

Family VASIDAE (Vase Shells)

Vasum ceramicum Linne. = Ceram Vase
Vasum turbinellus var. *cornigerum* Lamarck = Dog Chank or Pacific Top Vase

Family CASSIDAE (Helmet Shells)

Cypraecassis rufa Linne. = Bull-mouth Helmet or Red Helmet
Cassis cornuta Linne. = Great Horned Helmet Shell
Phallium torquata Reeve =
Phallium vibex Reeve =

Cypraecassis rufa shells were found on the reefs around both Male Atoll and Addu Atoll but they were not common. The huge *Cassis cornuta* shells were obtained only in Male ; they were reported to have been brought in from the waters around a small island in South Male Atoll, some 20 miles south of Male. It was reported that they were known only from this one island.

Family BUCCINIDAE (Whelks)

Colubraria maculosa Gmelin = False Triton Shell
Engina mendicara Linne. =

Family NATICIDAE (Moon Shells)

Polinices mamilla Linne. = The Moon Shell
Natica sp. =

Family TROCHIDAE (Top Shells)

Trochus maculatus Linne. = Maculated Top Shell
Trochus acutangulus =

Small Trochus shells were plentiful on the beaches of both Male and Addu Atolls ; many worn examples were found on the coral-sand beaches.

Family TRIDACNIDAE (Clam Shells)

Tridacna gigas Linne. = Giant Clam
Tridacna squamosa Lamarck = Fluted Giant Clam

Clams, generally small, were plentiful on all the reefs ; the larger ones were in the deeper water.

Family PTERIIDAE (Wing Shells and Pearl Oysters)

Pinctada margaritifera Linne. = Black-Lipped Pearl Oyster

Pearl Oysters appeared to be very uncommon in the atolls ; only a few of the Black-lipped forms were seen.

Pteria penguin Röding = Wing-Shell or Wing-Oyster

A single, highly-polished shell of this species was presented to us in Addu Atoll. It was stated to be very rare but found occasionally, in rather deep water in the central lagoon, growing upon sunken tree-trunks. It is highly prized by the Maldivians.

Family LUCINIDAE (Lucines)

Codakia punctata Linne. = Punctate Lucine
Codakia tigrina Linne. = Pacific Tiger Lucine

Family GARIDAE (Sanguin Clams)

Asaphis deflorata Linne = Gaudy Asaphis

Family PINNIDAE (Pen Shells)

Pinna sp. =

A single *Pinna*, about 6 inches in length, was found standing vertically in the wet coral-sand, at low tide on a wide coral reef in Addu Atoll. It was alive and was buried for most of its length, only about an inch of the shell being exposed above the sand.

Family GLYCYMERIDAE

Glycymeris sp. =

Very little effort was made to collect Bivalve shells—hence the small number represented in this collection. Bivalves were, however, common on the beaches.

NOTES AND REFERENCES

(K.R.S.)

The identification of the Shells in this collection is largely based upon those in my own collection. The books that I have used through the years are listed below. From my own experience of collecting marine shells on the shores and the reefs of Tanzania and the off-shore islands, I feel sure that there must be many more species and varieties to be found by anyone who has the time to devote to a concentrated search of the area. Experience of collecting has shown that it is amazing how even showy and conspicuous molluscs can blend into their background, burrow or otherwise conceal their presence.

ACKNOWLEDGEMENTS

My thanks are due to the assistance in identifying certain species given by several members of the Conchological Society of Great Britain, especially to the Reverend H. Biggs. (K.R.S.).

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An Ecological Survey of the larger Mammals of Peninsular India

BY

M. Krishnan

(*With fifty-five plates*)

(*Continued from Vol.* **69** (1): 54)

THE INDIAN ELEPHANT

Elephas maximus (Linnaeus)

(Summary of field notes: Observation records: 241

Locations: Kerala—Periyar Sa.; Tamil Nadu—Mudumalai Sa.; Mysore—Bandipur Sa.; Orissa—Similipal hills; Bihar—Palamau N.P., Singhbhum.

Outside peninsular India: West Bengal—Jaldapara Sa.; Assam—Kaziranga & Manas Sas.; Uttar Pradesh—East Dehra Dun, Corbett N.P.

Photographs: K2, K3, K4, K5, K6, K9, K10, K11, K13, K14, K17, K18, K21, K22, K23, K24, K25, K26, K27, K29, K30, K35, K36, K37, K38, K39, K40, K41 and K43.

TN 5, TN 6, TN 27, TN 28, TN 29, TN 33, TN 38, TN 51, TN 52, TN 56, TN 61 and TN 62.

MY 3, MY 4, MY 5, MY 7, MY 9, MY 10, MY 16, MY 17, MY 19, MY 22, MY 23 and MY 35.

B2, B12, B16, B20 and B21.

MISC 2, MISC 3, MISC 4 and MISC 5).

Although this is the report of an ecological survey, not primarily concerned with habits, behaviour, and external morphology, and although some literature on *Elephas maximus* occurring outside peninsular India is available, it is necessary to provide some account of, the habits, behaviour and physical characters of the animal here.

Size : Morphological characters

Old Indian shikar and faunal literature exhibits a tendency surprisingly unusual in it, to be conservative in estimating the height of an elephant. The build of the animal is such that the height at the shoulder is a less reliable indication of size than with most other animals—the length and circumference of the body, the thickness of the limbs and trunk, and the relative size of the head and body vary so much with individuals that the indigenous system of classifying elephants into the *koomeriah*, *meerga* and *dwasala* types recognises that animals of all three types may be seen in the same herd. In a large herd of over 50 elephants closely observed (and photographed) there was a striking variety of build and conformation noticed (K 60 Apr. 5). When it is possible to follow a herd of elephants and watch them for sometime, it is not difficult to distinguish between individual members of the herd by their peculiarities of build.

G. P. Sanderson's much-quoted opinion, 'There is little doubt that there is not an elephant 10 feet at the shoulder in India', was published late in the 19th century. In the section on 'Indian Shooting' by Lt. Col. R. Heber Percy in C. Pillipps-Wolley's compilation, BIG GAME SHOOTING (London, 1895), this interesting information is provided: 'The skeleton of the well-known Arcot rogue elephant, now in the Madras Museum, measures 10 ft. 6 ins. at the shoulder. Mr. Rowland Ward considers that when alive it must have stood 10 feet 10 ins.' The mounted skeleton is still at the Government museum in Madras and still measures 10 ft. 6 in., as personally verified.

It is true that a bull elephant over 10 ft. 6 in. high or a cow over 9 feet is so exceptional that it must be left out of consideration in judging adult size, but though I myself have never seen a 10-foot elephant, to fix this as the maximum height attained by a big bull is incorrect. I measured 3 undefaced prints of the forefoot of a big bull in the Manas Sanctuary (Assam) and all 3 gave the height at the shoulder at over 10-foot 2-inch.

Incidentally, it is practically impossible to measure the height of a dead elephant: if the animal subsides on its belly, the feet are bent: if it falls on a flank, the sag of the shoulder is so great that the front leg which is uppermost (naturally, the lower leg cannot be measured) may be extended or retracted: a further complication is that this foreleg in death usually slopes down towards the ground (exceptionally, in *rigor mortis*, the foreleg may remain parallel to the ground, in the corpses of 2 elephants electrocuted by accidental contact with a low-slung high-voltage cable, the upper foreleg jutted out of the body rigidly, well off the ground—MISC 68 May 16). Furthermore, without the weight of the body on the legs, the height cannot be measured reliably: in 2 experiments camp elephants were made to recline on their flanks and keep the foreleg straight out: measurements of the distance between shoulder and sole varied within wide limits and was much in excess of the height of the animal measured when it was standing.

Even with tamed elephants, unless there are necessary facilities for accurately measuring the height when the animal is standing on level ground, measurement of the height of the shoulder may vary within wide limits. For example, the tusker Kali Prasad, stationed at Manas in February 1968, was over 10-foot as high as measured by the Range Officer and only 9-foot 9-inch as measured by me.

Provided the elephant is not malformed or exceptionally short-legged, the rule that twice the circumference of the forefoot will give the height at the shoulder within an inch or so is quite reliable with adult elephants. This is the *only* way to know the height of a wild elephant. Here, again, care and accuracy in measuring the circumference are essential for reliability. It is the clear, undefaced print of the forefoot that must be measured (as where the animal has turned sharply) and it is often said that this print must be on hard dry ground and not on moist soil, because in soft soil the foot-print tends to splay. It does not. The sole of an elephant's foot does not splay in the manner of the pug of a tiger or even the slots of a sambar on wet soil. Of course in loose sand, the imprint is not clear and the sand pushed out at the periphery leads to errors, and in mire (when the foot is pulled out of the mire at each step) there is never a clean imprint, but it is on moist earth, as on the edges of paddy fields or on bare ground after a rain, that the clearest imprints will be found. I have measured the forefoot print of the same elephant on such moist ground and also on firm ground a few yards away, and it was the print on hard dry ground that gave a circumference greater by an inch: this is because with slightly yielding soil it is not only the cushioned sole of the animal that gives beneath its great weight. The method used by me is to lay a thin, non-stretchable cord, inch by inch, along the inner line marking the circumference, with no sag in the cord: small sharp slivers of wood driven vertically into the periphery of the footprint help in this. The total length of the cord marking the circumference, is then measured. With care this method gives unvarying measurements. The diameter should not be measured for two reasons: first, the forefoot imprint of the elephant is not perfectly circular and therefore the circumference cannot be calculated by multiplying the diameter by $3\frac{1}{7}$; second, even small errors become material in such a calculation for by the time the height of the elephant is computed the diameter, and therefore the error, has been multiplied $6\frac{2}{7}$ times.

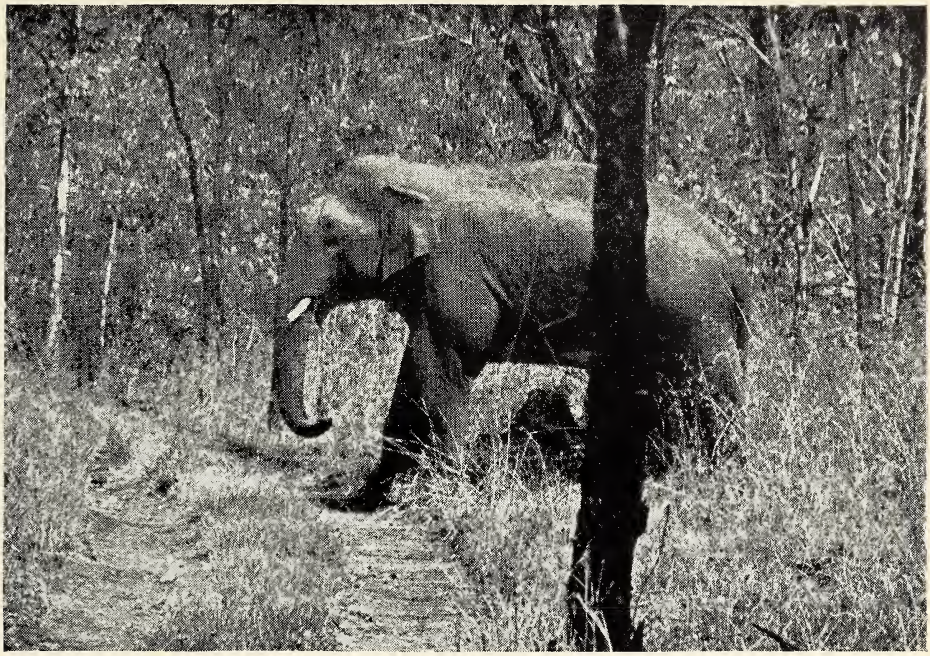
As already said, height is only one dimension in assessing size in an elephant. The length of the body varies considerably, especially in big bulls, as also its thickness. A massive bull fully 6 inches shorter than a leggy, thin animal may easily defeat the latter in a fight.

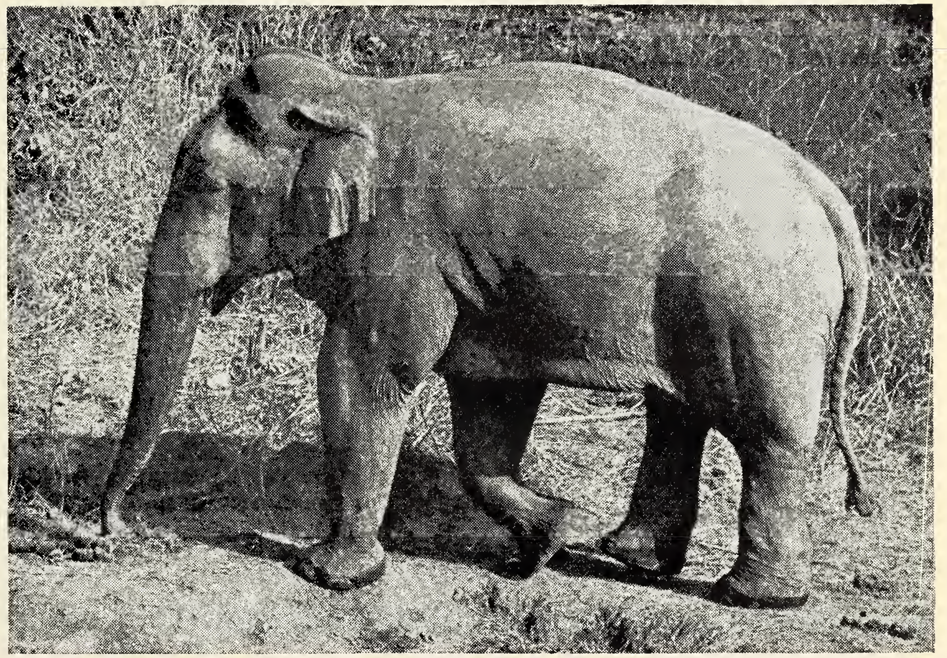
Length of tusks, in adult bulls, especially in old bulls, convey no idea whatever of size. The biggest tusks are carried by bulls whose tusks slope down to the ground, and these are generally thin. Nor does the mere thickness of the tusks reflect size or power, though an animal with horizontally carried thick tusks, especially when these project about 3 feet from the gums and are evenly curved, is usually stout, long-barrelled and powerful (photographs K2, K5 and K6); very long tusks, such as the 'record tusks' cited in the literature on elephants, are no indication of the bull carrying them being of exceptional size: on the contrary, such animals are usually only of average size. Such tusks are a constant embarrassment to their owner, hindering free movement (especially of the head and trunk) and being a serious handicap in intraspecific fights, sometimes even in feeding. Thin, sharp-pointed, curved tusks are murderous weapons in intraspecific combats (photograph MISC 2, TN 61).

Mucknas may be found all over the range of the elephant in India and are not regional features; for instance they occur in Kerala, Tamil Nadu, Mysore, Orissa, Bihar, West Bengal and Assam. However, they are commoner in Assam and Bihar than in the southern States of India (TN 59 Mar. 5, 66 Apr. 5; MISC 68 Feb. 10; B 69 Feb. 19, 23). Tuskers have one or both tusks frequently broken accidentally or in intraspecific combats (B 68 Apr. 24—photograph B2; MY 68 Oct. 9). Sometimes an entire tusk may be lost, usually in a fight, and then the bull has only one tusk visible and is termed a 'Ganesha' (TN 63 Sep. 20, 70 Sep. 23). The camp elephant Caesar which was stationed at the Mudumalai Sanctuary for many years (till his death) had a tusk wrenched away in an engagement with a wild tusker. Cows, even when adult or old, frequently carry short tusks, projecting a few inches from the lips—these are called 'scrivelloes' in the ivory trade in India. There seems to be no regional bias to the possession of tushes by cows, and it is much commoner than is generally realised (K 70 Apr. 23).

Weight is a much more reliable indication of size in an elephant than measurements, but naturally it is very seldom possible to weigh such a huge beast and there are few reliable records. The weight of tamed elephants is no guide, for it is seldom that an elephant in captivity attains the mass and musculature of wild elephants. A very big bull may probably weigh between 4 and 5 tons. The height of a newborn calf varies from about 30 inches to 36 inches and its weight is around 200 lb.

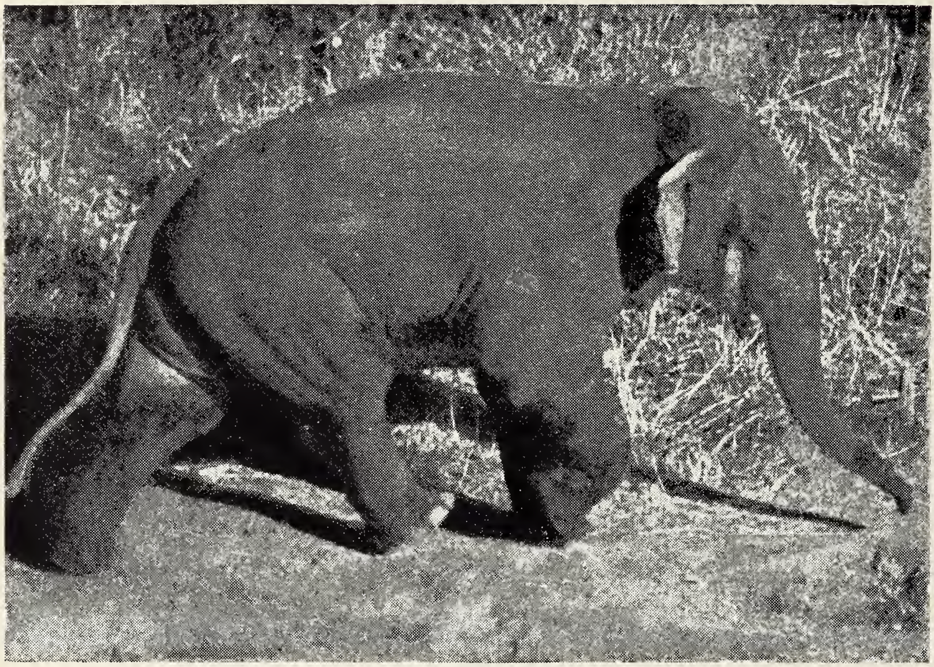
The colour of an adult elephant is largely a question of the colour of its skin, for when full-grown the hair on the body is too sparse to influence colour. Some animals have a lighter coloured skin and some much darker skin: in the lighter grey animals there is often

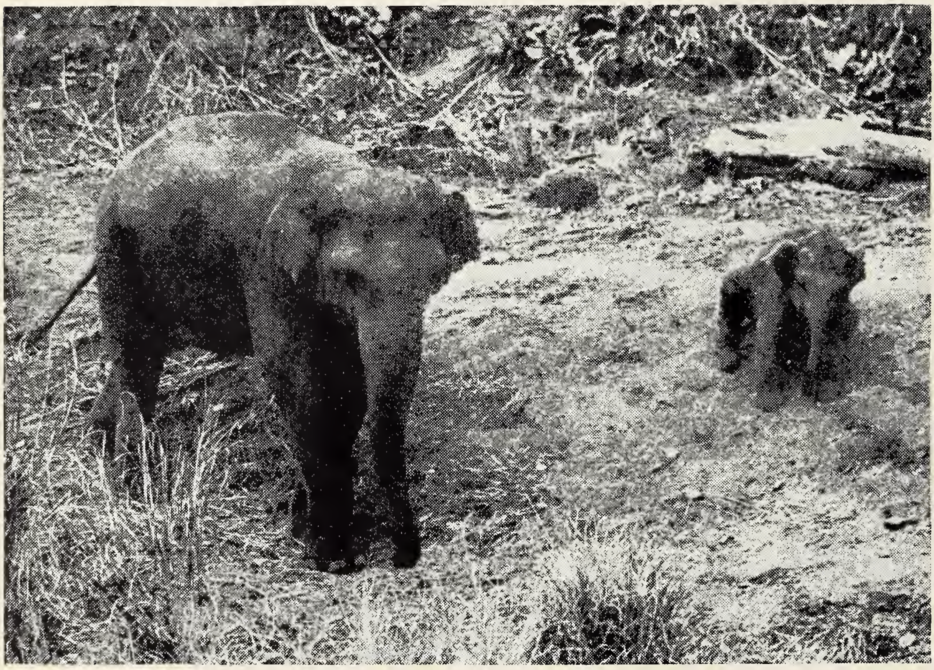




Above : BIHAR 1968 : BARESAND SA. : April 24 — a.m. : The bull with the broken tusks — B. 2 ; *Below :* BIHAR 1969 : BETLA : PALAMAU : February 19 — About 3.15 p.m. : The big cow, at Hathbajhwa — B. 12.

(*Photos : M. Krishnan*)

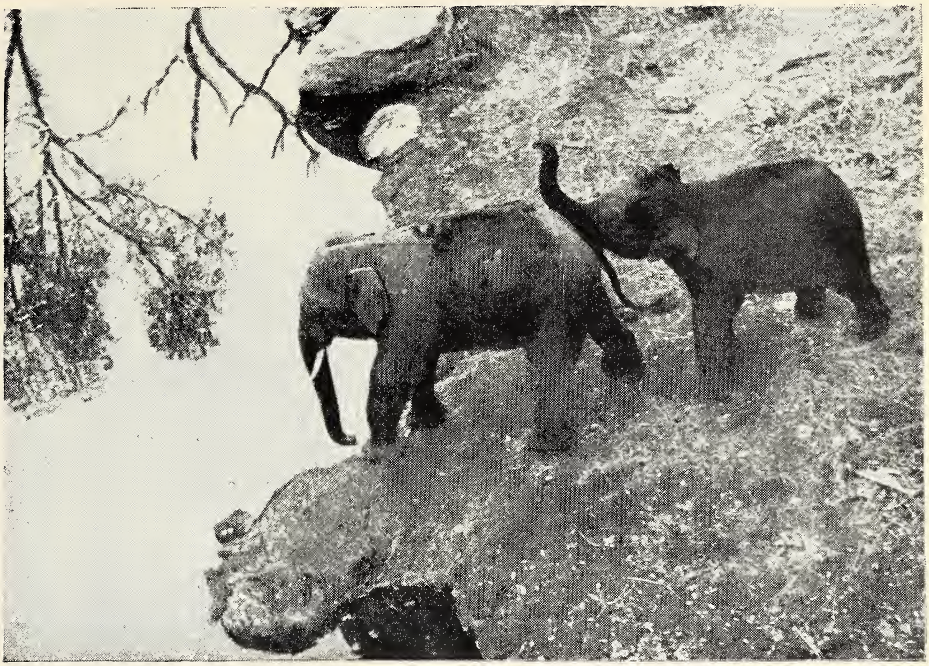


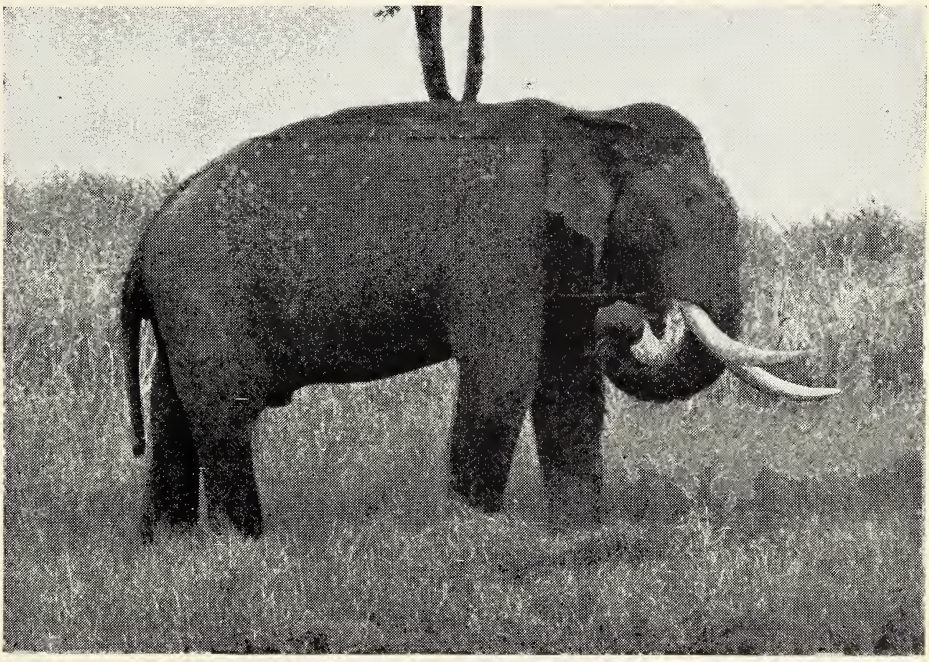


Above : BIHAR 1969 : BETLA : PALAMAU : February 23 — About 4.30 p.m. : The larger muckna going flat out, chasing the smaller. Note musth stain on cheek — B. 16 ; *Below :* BIHAR 1969 : BETLA : PALAMAU : February 26 — p.m. : Young calf staging a sit-down strike — B. 20.

(*Photos: M. Krishnan*)

Krishnan : Mammals

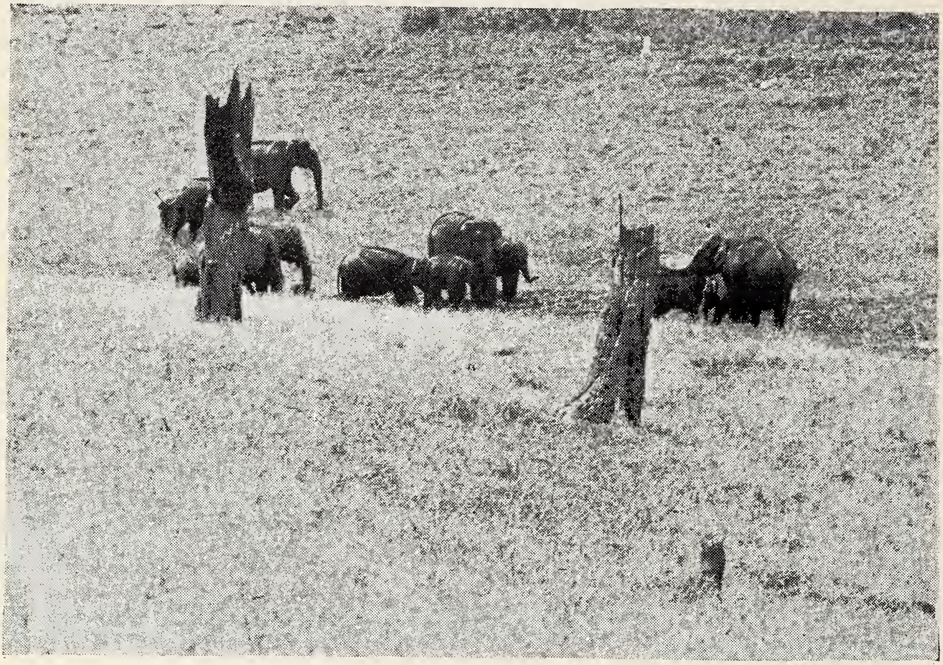


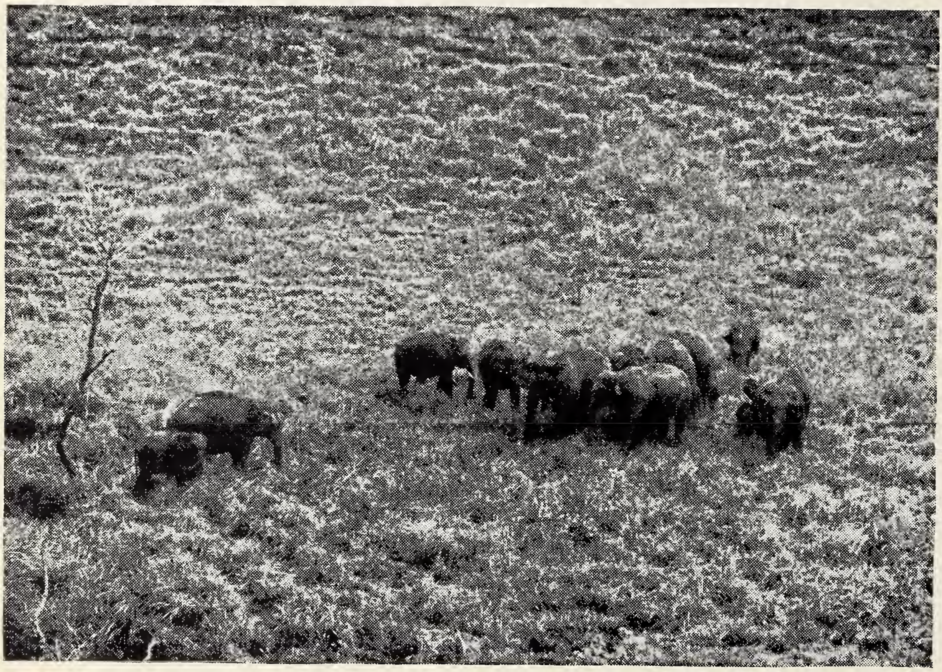


Above : BIHAR 1969 : BETLA : PALAMAU : February 26 — p.m. : Subadult elephants at play at the pool at Hathbajhwa — B. 21 ; *Below :* PERIYAR SA. : KERALA : May 20, 1959, a.m. : Tusker with tusks over 3-foot long — the presumed winner of the fight. Note raised weal above thigh — a tusk-wound — K. 2.

(*Photos : M. Krishnan*)

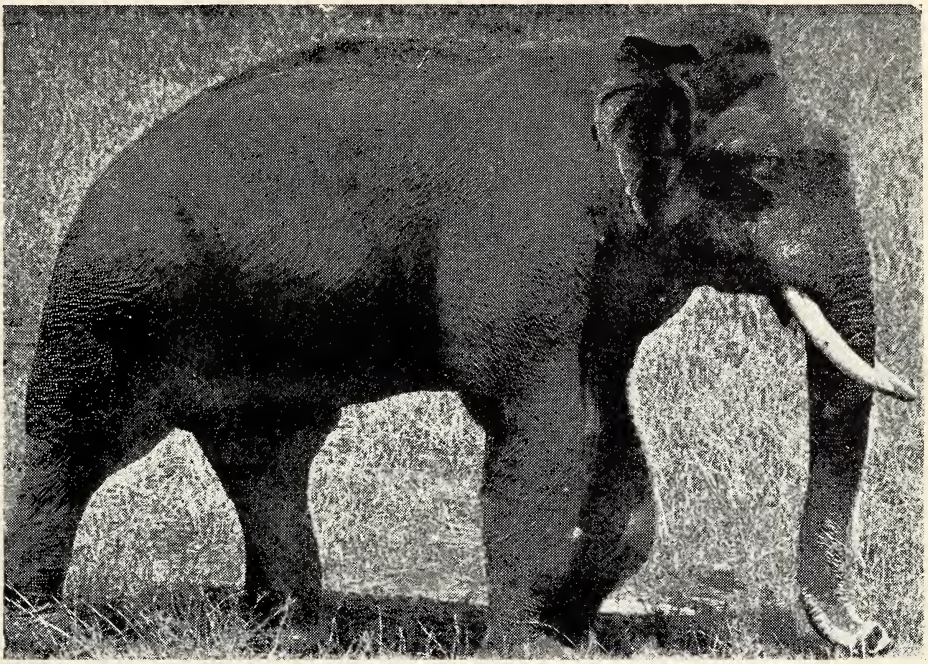
Krishnan : Mammals

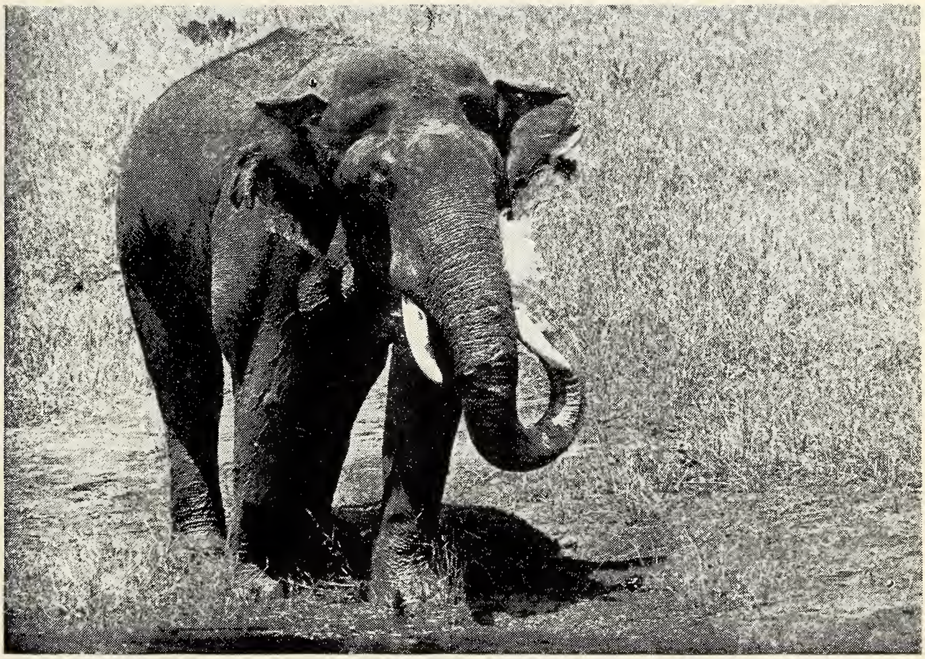




Above : KERALA 1969 : PERIYAR SA. : April 3 — p.m. : Herd of 12 elephants at an inland pool — K. 3 ; *Below :* KERALA 1960 : PERIYAR SA. : April 4 — a.m. : Herd of elephants grazing on a hill, near Koyyathotti — K. 4.

(*Photos : M. Krishnan*)

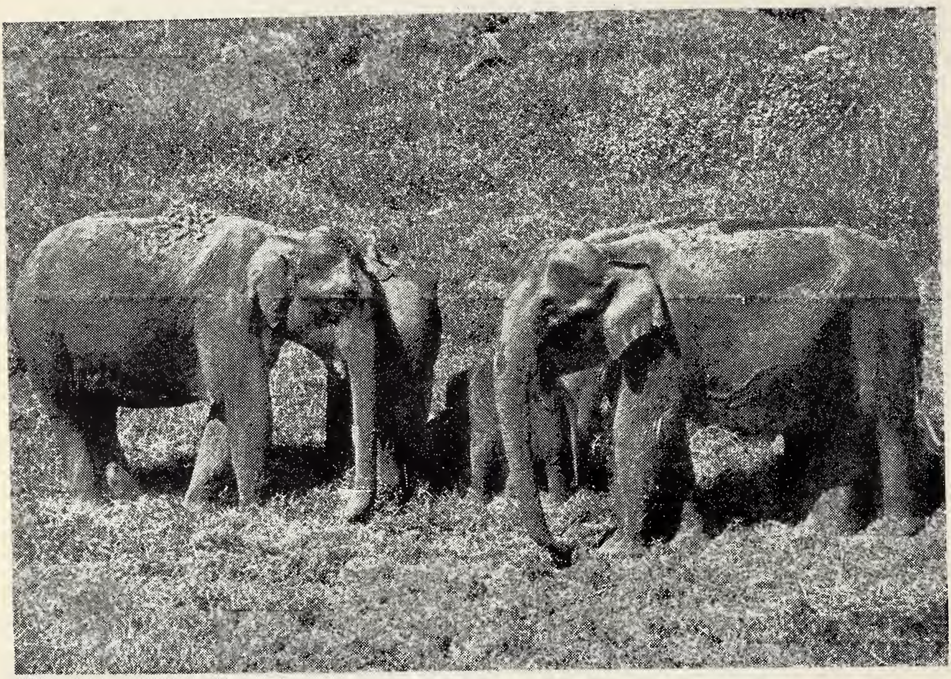


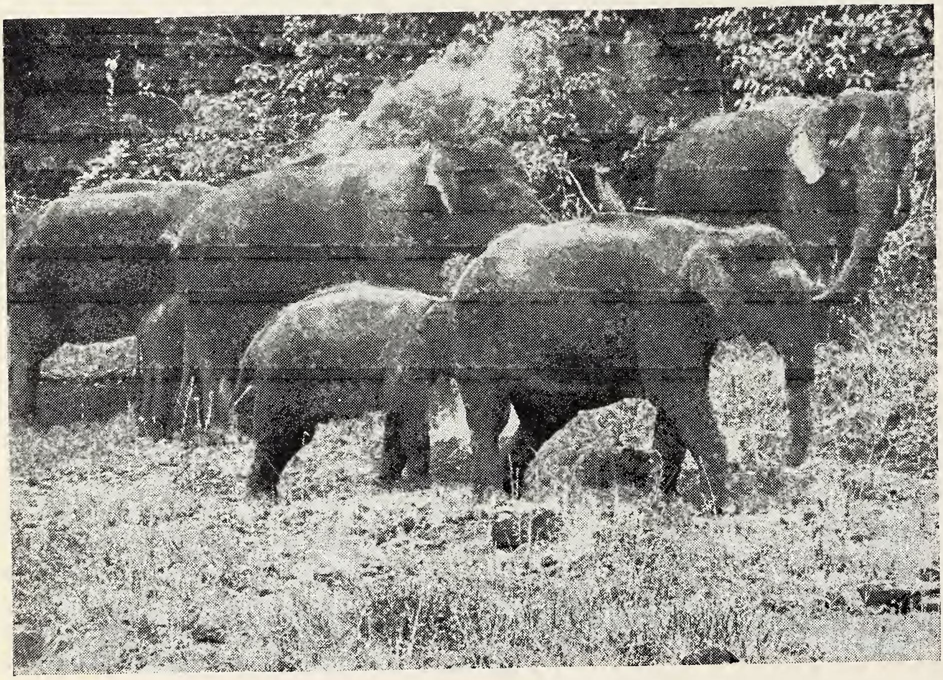


Above : KERALA 1960 : PERIYAR SA. : April 10 — a.m. : A perfect koomeriah. 9′ 10″ as per forefoot imprint : in musth — K. 5 ; *Below :* KERALA 1960 : PERIYAR SA. : April 10 — a.m. : Same lone tusker as in previous picture laving his swollen musth-glands. Note adherent clay on tusk and wounds on legs and trunk — K. 6.

(*Photos : M. Krishnan*)

Krishnan : Mammals

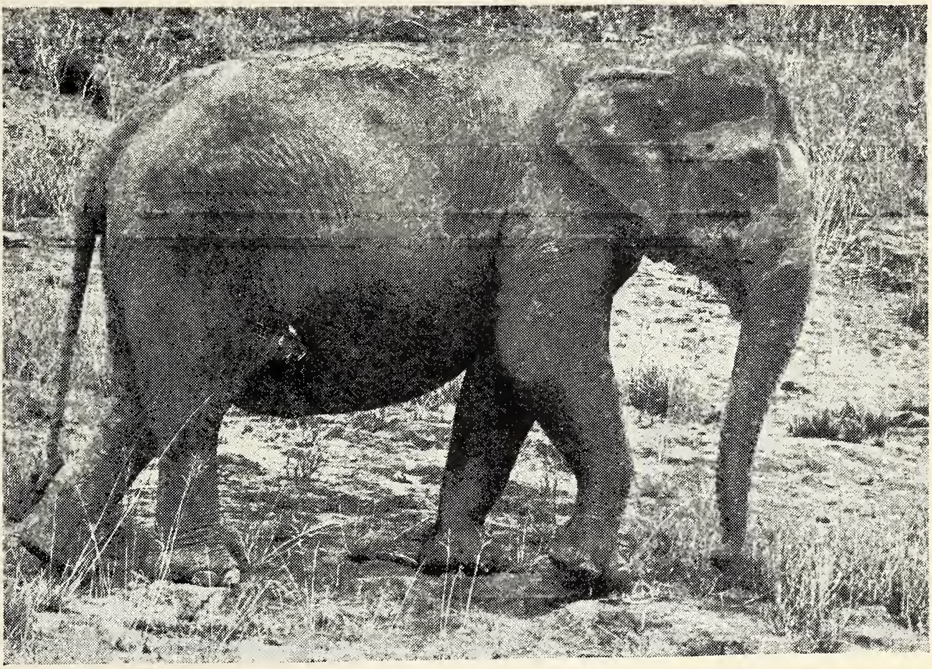


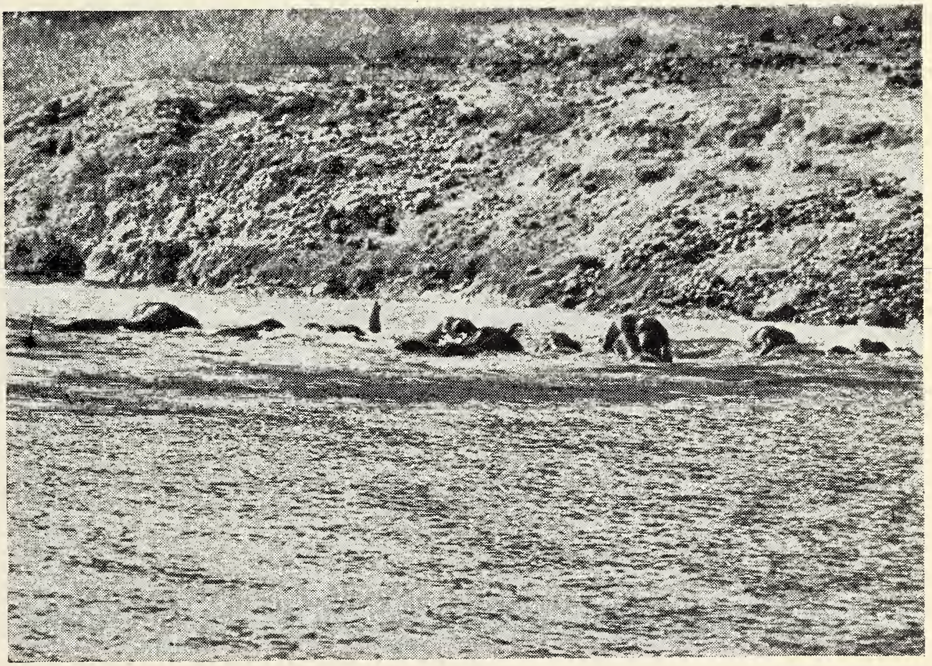


Above : KERALA 1970 : PERIYAR SA. : April 20 — a.m. : The 'conference' breaking up — K. 9 ; *Below :* KERALA 1970 : PERIYAR SA. : April 22 — p.m. : Cow elephant dusting herself after a swim. Note lacing of pink to edge of ear in 2 cows — K. 10.

(*Photos : M. Krishnan*)

Krishnan : Mammals

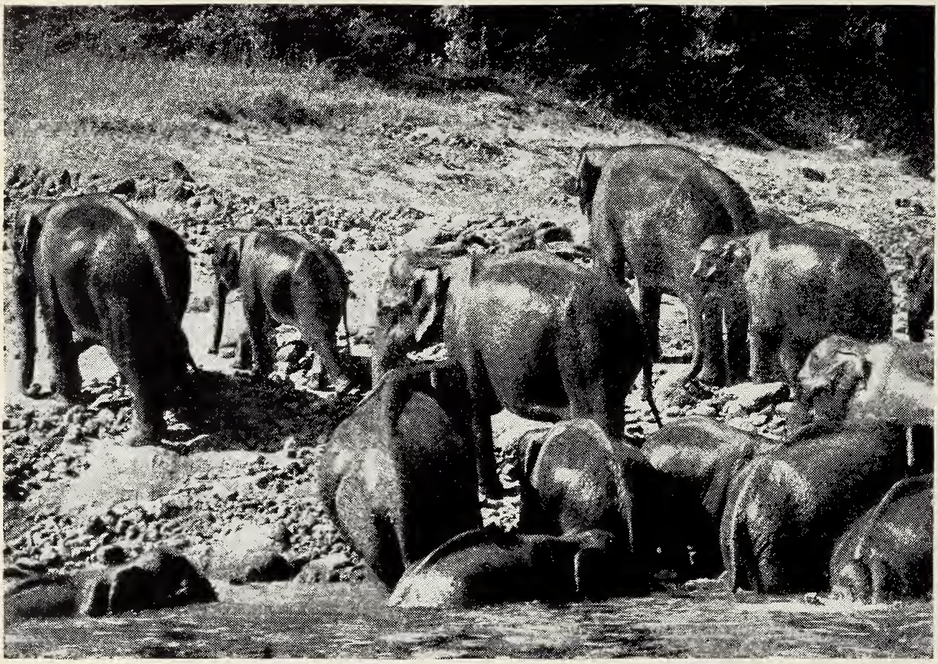


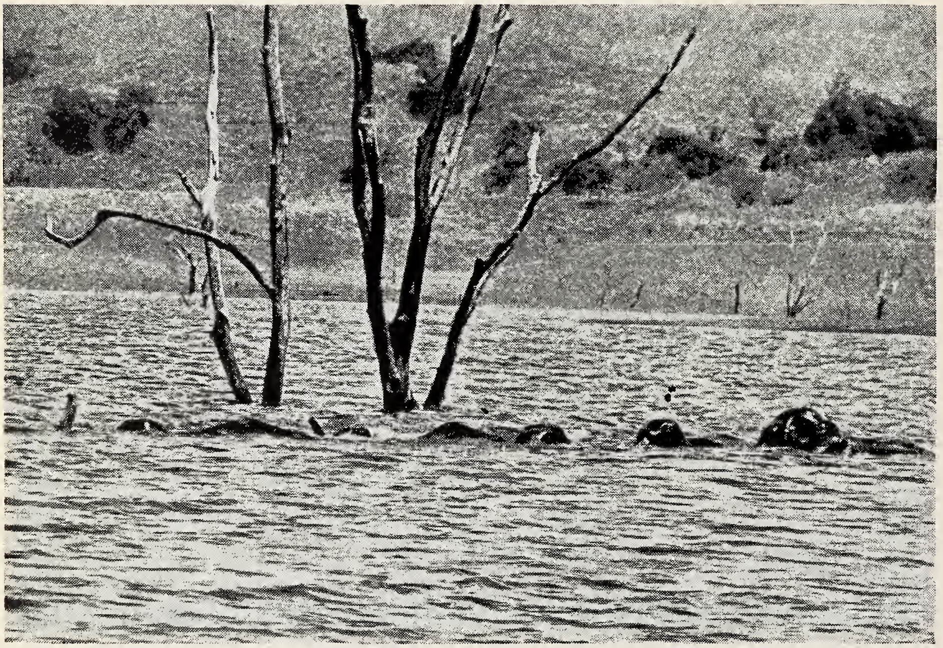


Above : KERALA 1970 : PERIYAR SA. : April 22 — p.m. : Pregnant cow in musth (note black spot around pore of musth-gland — other pix of this cow show a similar spot on the left side, too) — K. 11 ; *Below :* KERALA 1970 : PERIYAR SA. : April 23 — a.m. : Elephants swimming across the Periyar. Note the landing, to the right, for which they are making — K. 13.

(*Photos : M. Krishnan*)

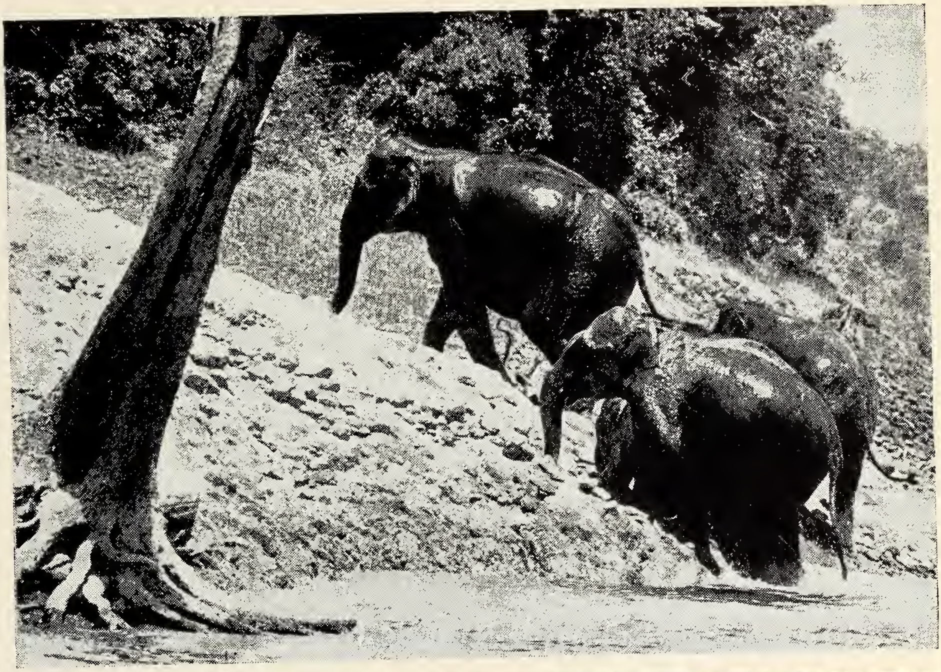
Krishnan : Mammals

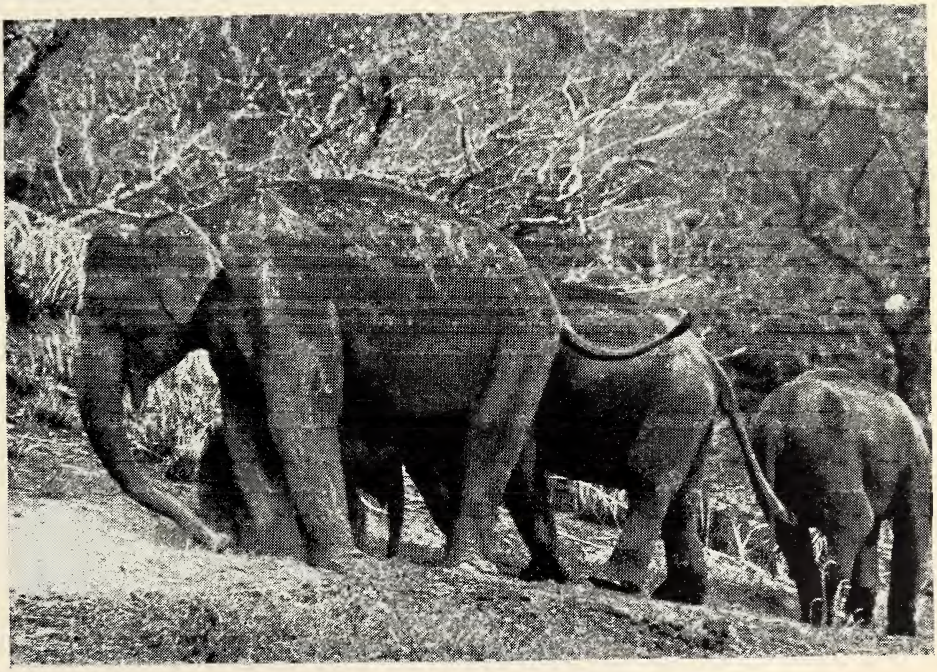




Above : KERALA 1970 : PERIYAR SA. : April 23 — a.m. : Elephants climbing ashore after the swim (see previous picture). Note border of pink to the ear of the central cow — K. 14 ; *Below :* KERALA 1970 : PERIYAR SA. : April 29 — a.m. : Elephants swimming across the Periyar — side view — K. 17.

(*Photos : M. Krishnan*)

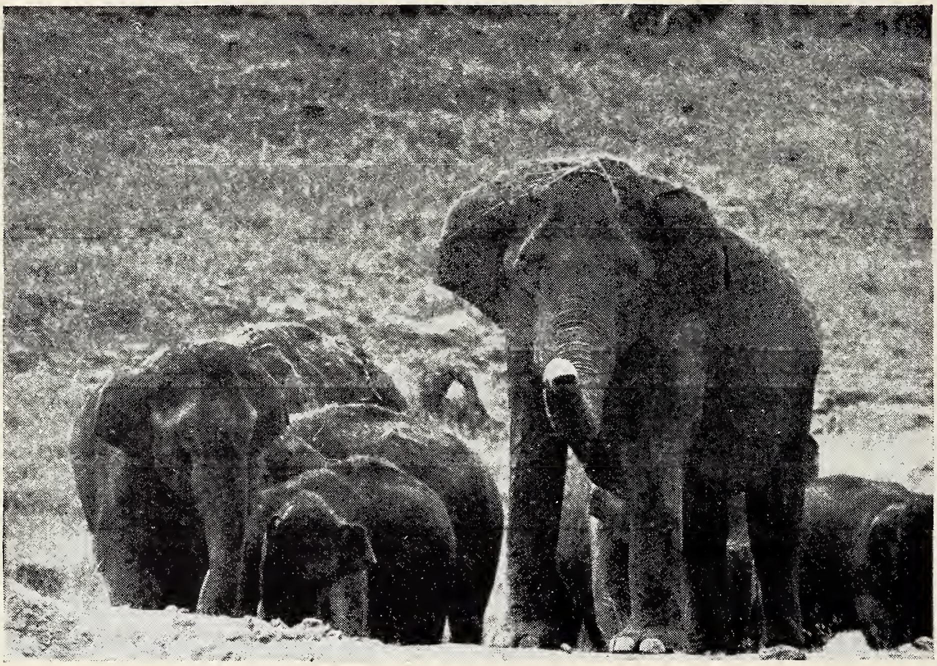


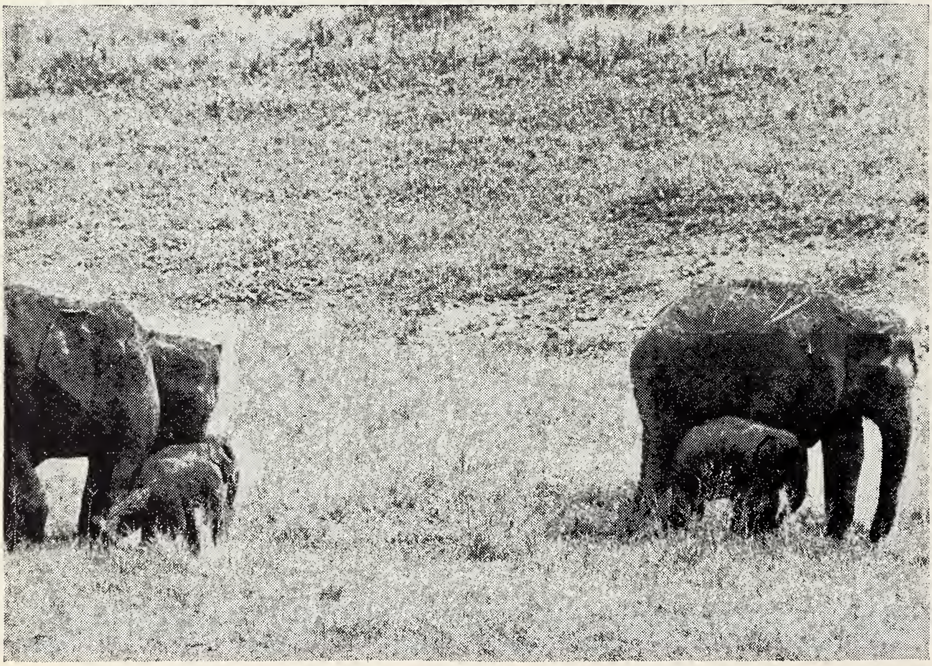


Above : KERALA 1970 : PERIYAR SA. : April 29 — a.m. : The same party shown swimming in the previous picture climbing ashore. Note gradual slope of landing — K. 18 ; *Below :* KERALA 1970 : PERIYAR SA. : April 30 — a.m. : Cow scraping and eating salt-earth — note the encumbering calf — K. 21.

(*Photos : M. Krishnan*)

Krishnan : Mammals

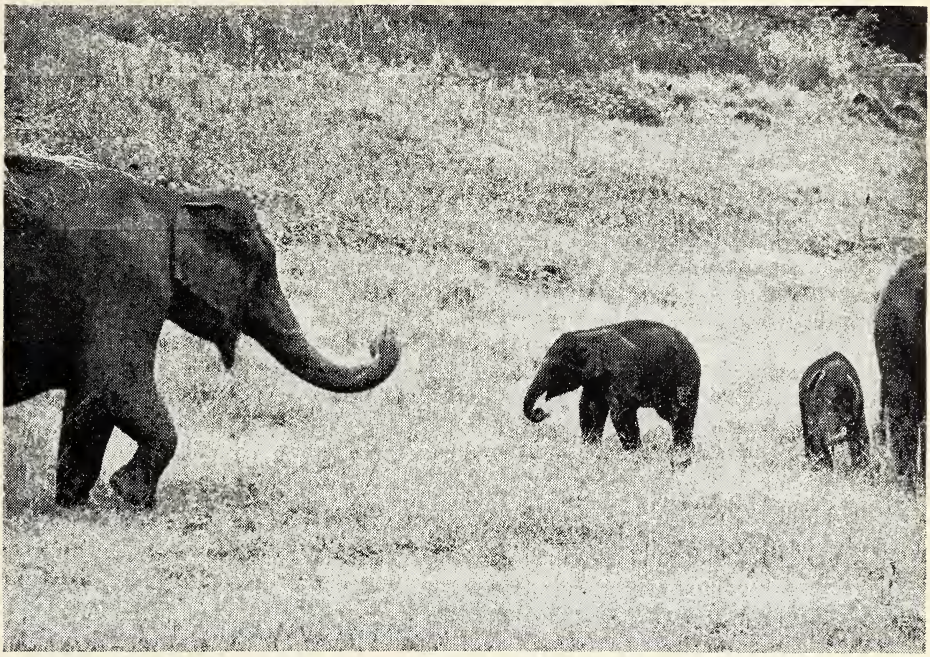


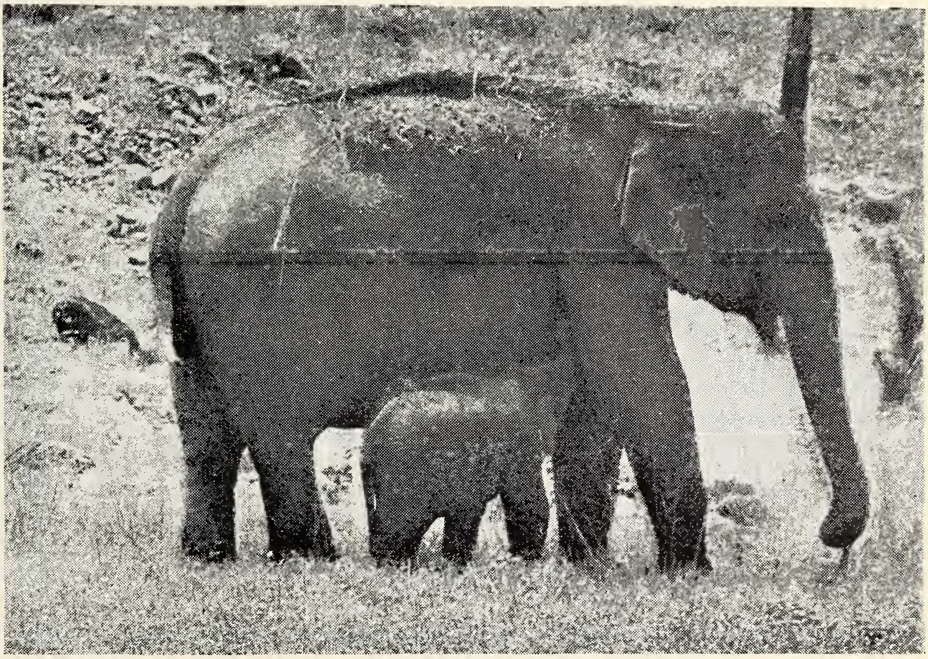


Above : KERALA 1970 : PERIYAR SA. : May 1 — a.m. : Cow smelling me — the elephants following her left the path and went away — K. 22 ; *Below :* KERALA 1970 : PERIYAR SA. : MAY 1 — a.m. : A calf, lying down in its mother's path, being hoisted to its legs — K. 23.

(*Photos : M. Krishnan*)

Krishnan : Mammals

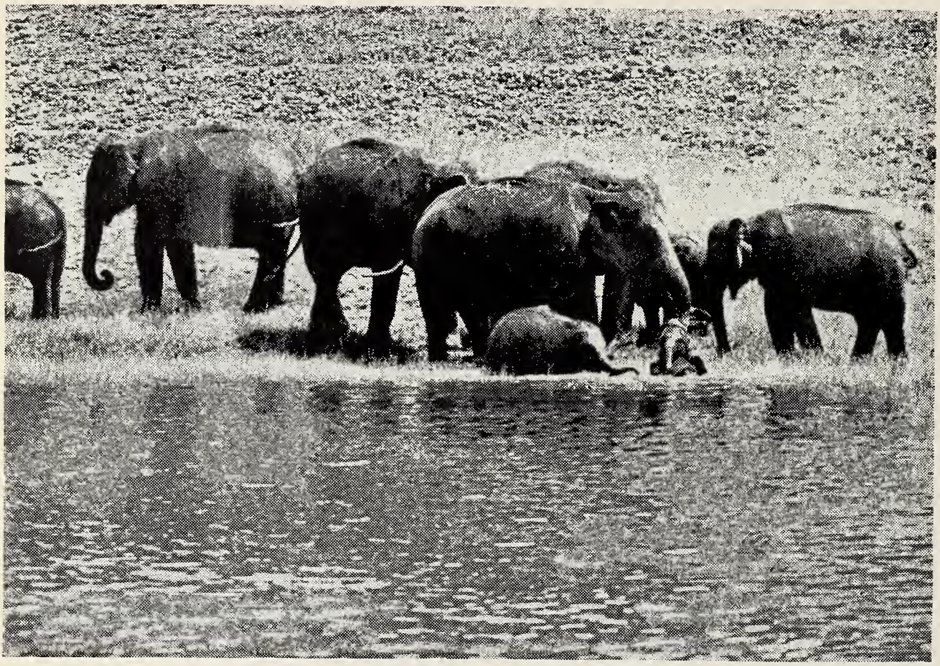


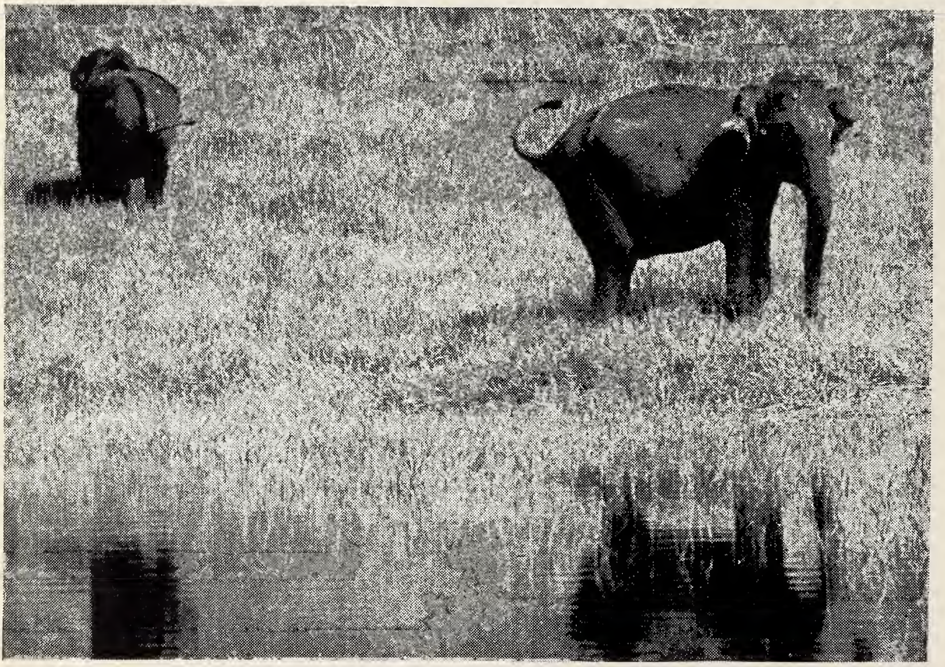


Above : KERALA 1970 : PERIYAR SA. : May 1 — a.m. : Calf in previous picture waiting for its mother after a spell of play with another calf — K. 24 ; *Below :* KERALA 1970 : PERIYAR SA. : May 1 — a.m. : A big cow suckling her calf — K. 25.

(*Photos : M. Krishnan*)

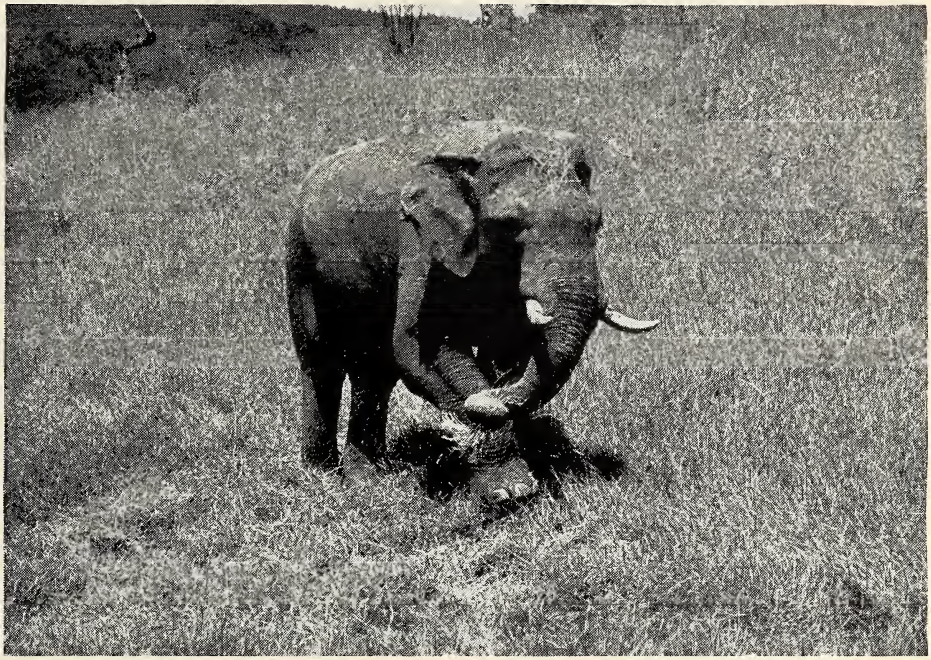
Krishnan : Mammals

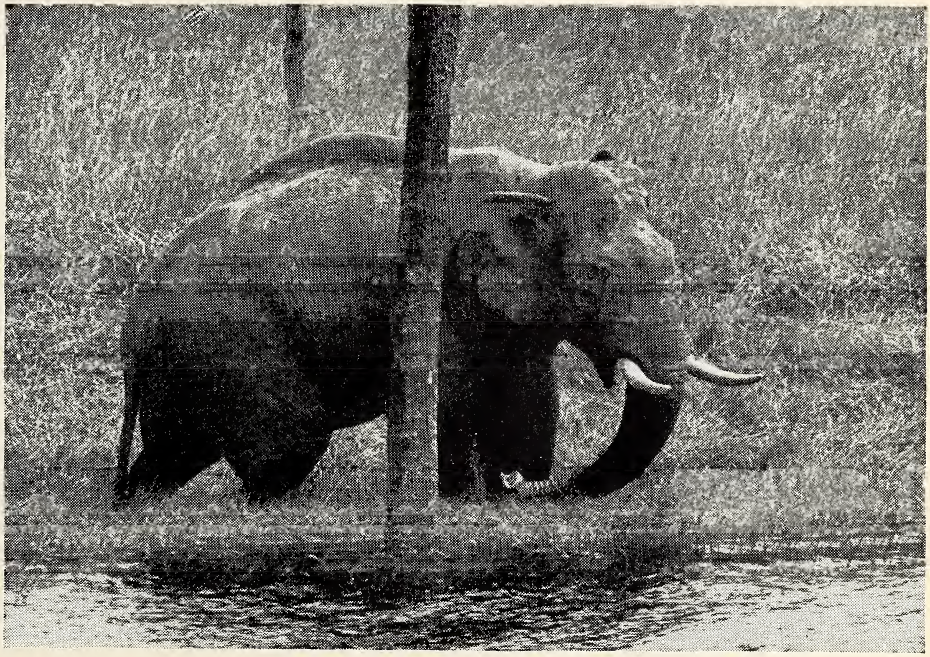




Above : KERALA 1970 : PERIYAR SA. : May 2 — a.m. : Calves playing in the water — K. 26 ; *Below :* KERALA 1970 : PERIYAR SA. : May 3 — a.m. : Typical attitude of a cow panicking — K. 27.

(*Photos : M. Krishnan*)

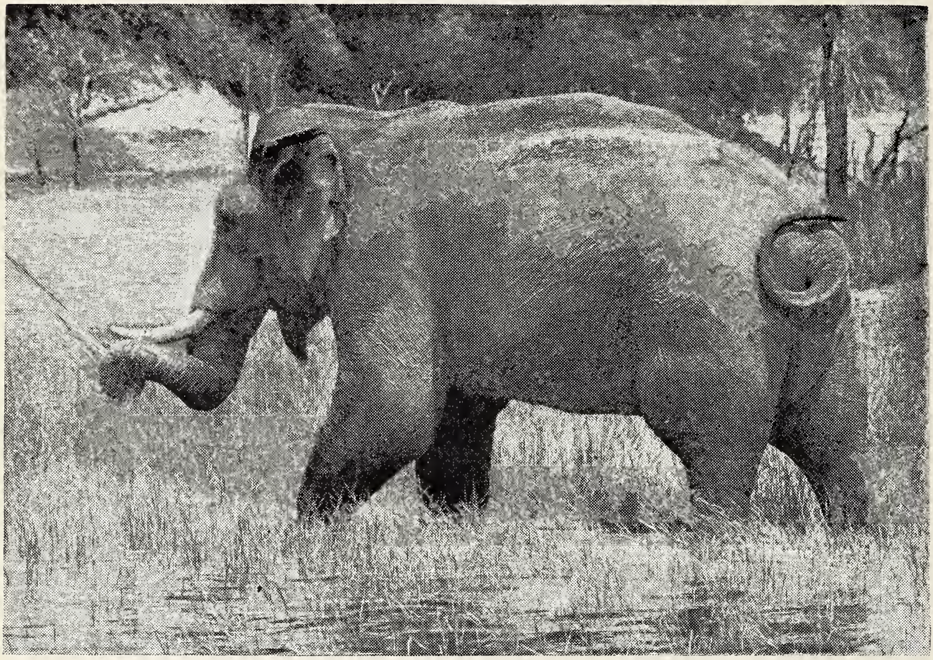


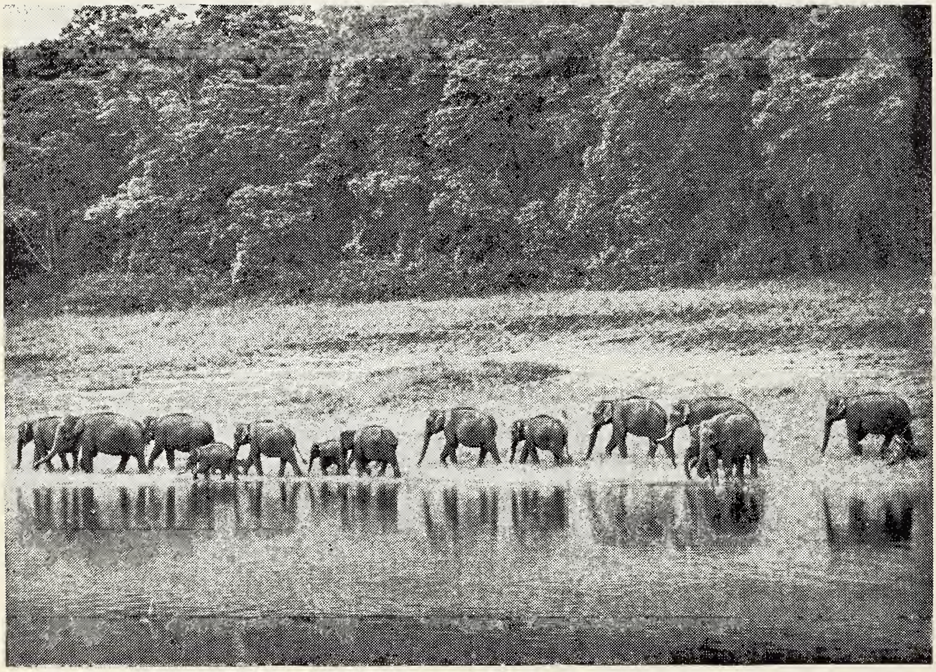


Above : KERALA 1970 : PERIYAR SA. : May 6 — a.m. : Lone tusker at Aruvi dusting grass against his knee — K. 29 ; *Below :* KERALA 1970 : PERIYAR SA. : May 6 — p.m. : The lone tusker on the island. He was not rubbing himself against the deadwood, but turning sharply past to get near the boat — K. 30.

(*Photos : M. Krishnan*)

Krishnan : Mammals

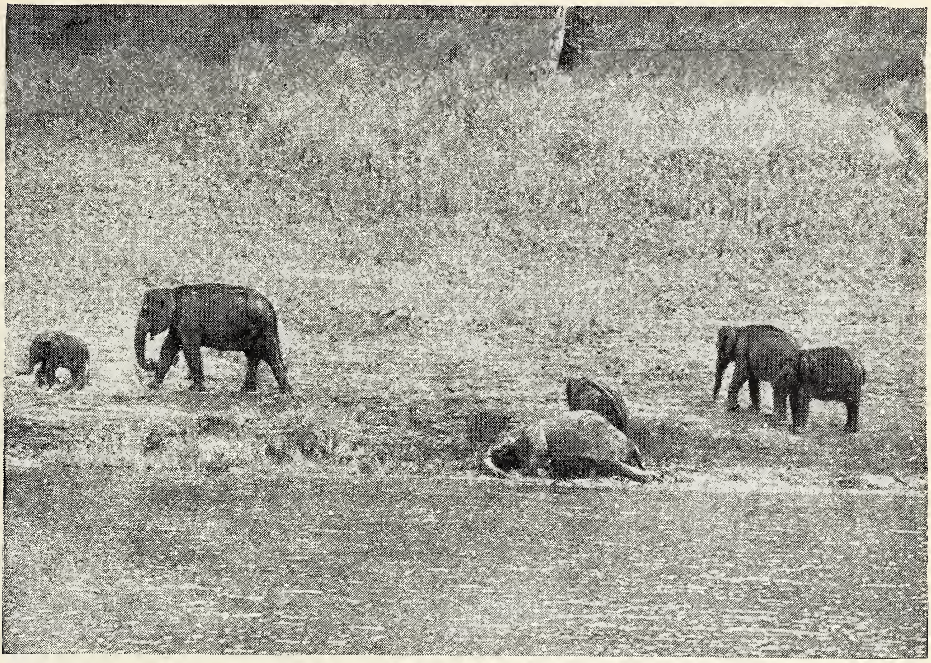


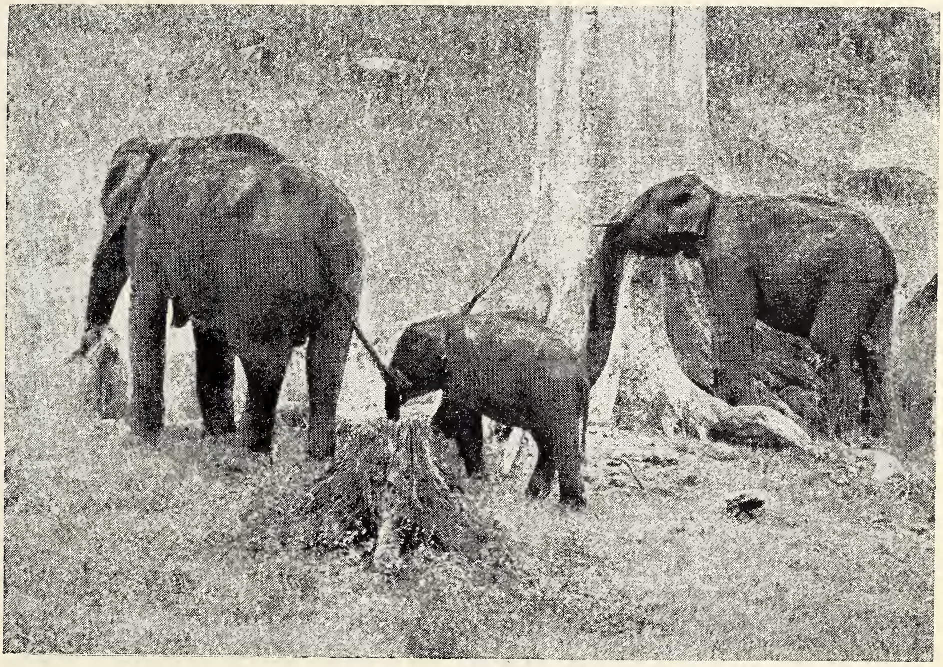


Above : KERALA 1970 : PERIYAR SA. : May 8 — a.m. : Lone tusker feeding on submerged grass and sedge — K. 35 ; *Below :* KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 16 elephants in the bay behind the rest-house — K. 36.

(*Photos : M. Krishnan*)

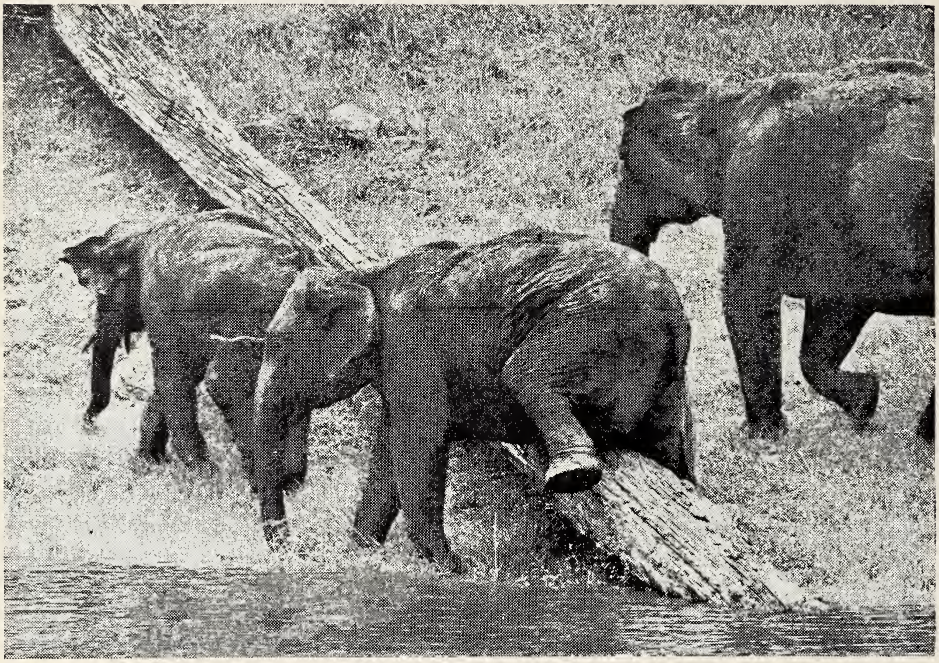
Krishnan : Mammals

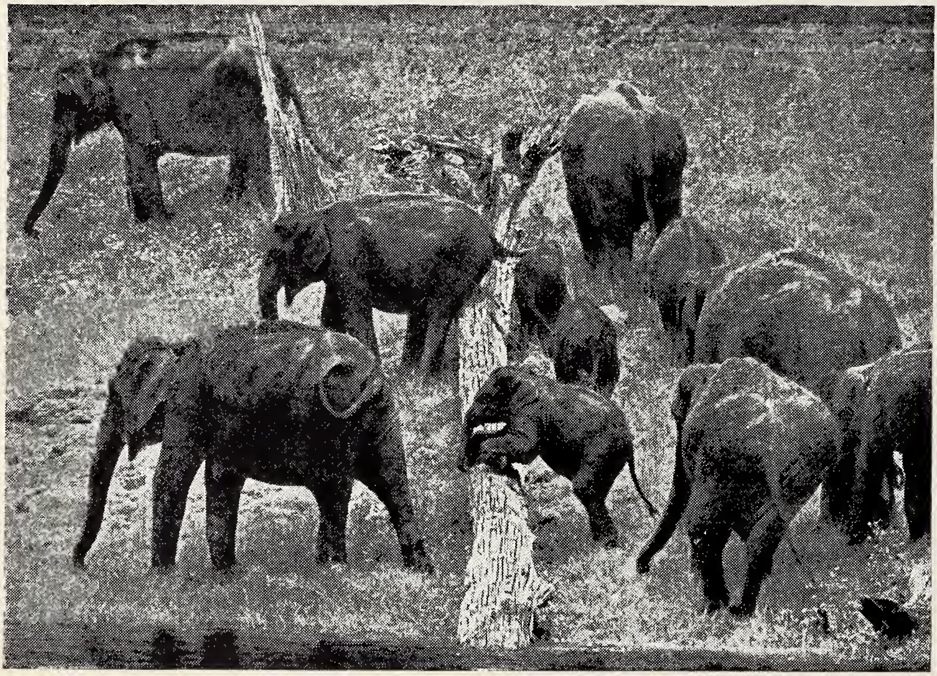




Above : KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 20 elephants in a bay : Cow having a wallow — K. 37 ; *Below :* KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 20 elephants in a bay. Young tusker rubbing himself against tree. Note turgid, outwardly-directed breast of cow — K. 38.

(*Photos : M. Krishnan*)

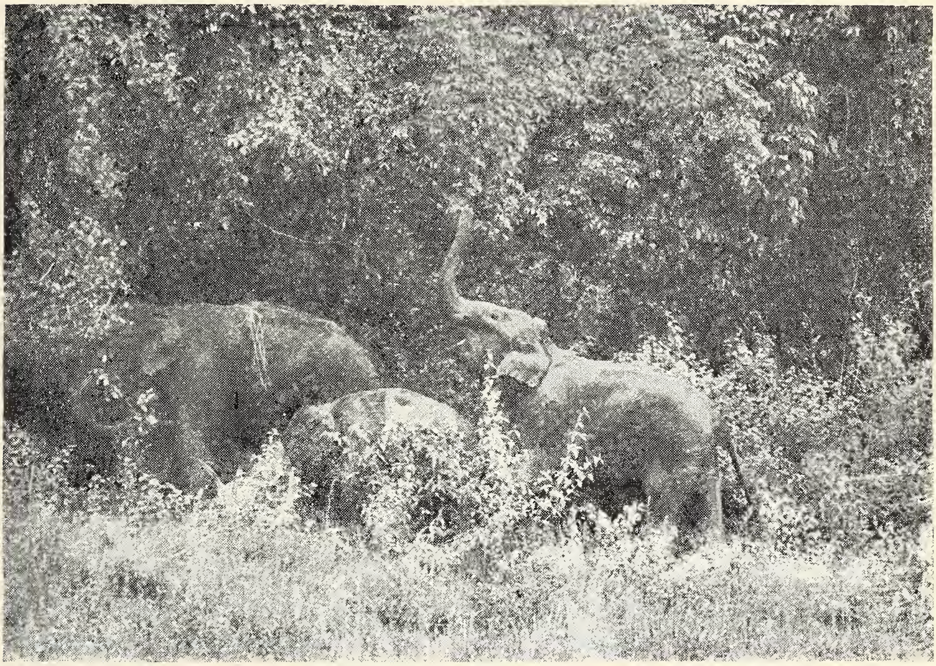


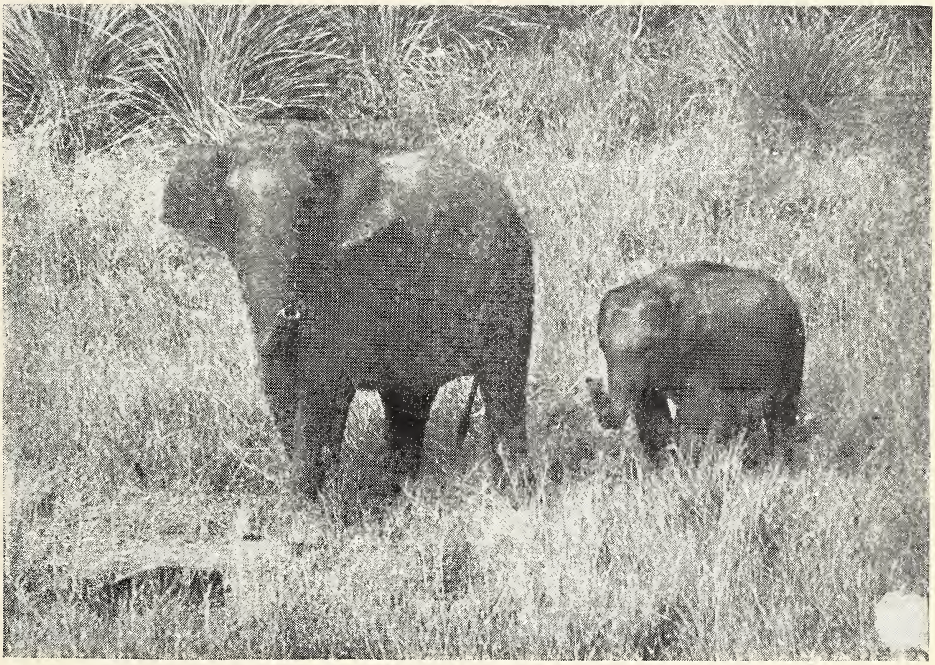


Above : KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 20 elephants in a bay. Grown cow crossing the log — K. 39 ; *Below :* KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 20 elephants in a bay. Calf attempting to get over the log : Note cow leading young round obstacle — K. 40.

(*Photos : M. Krishnan*)

Krishnan : Mammals

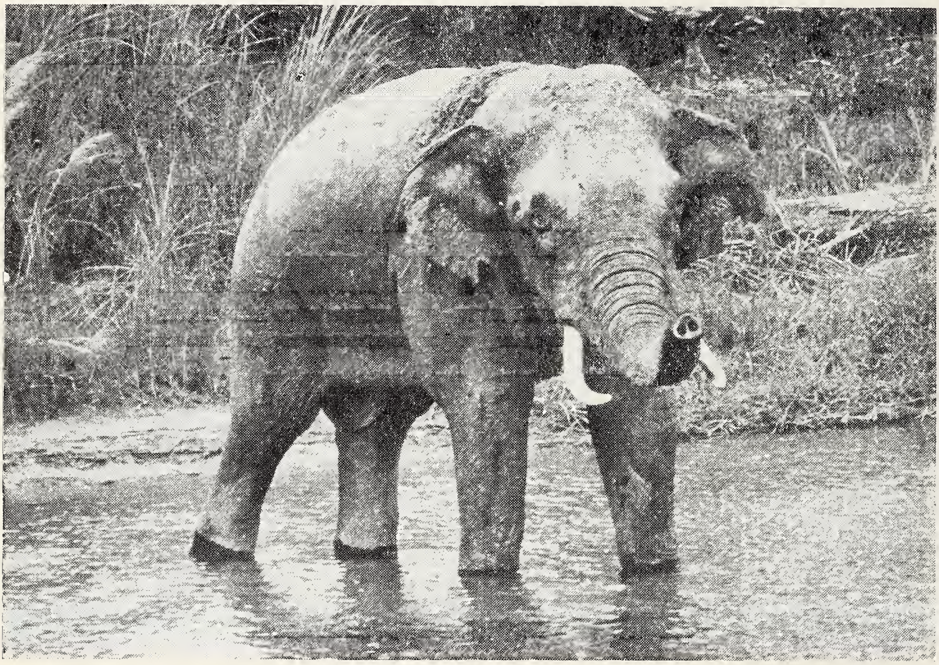


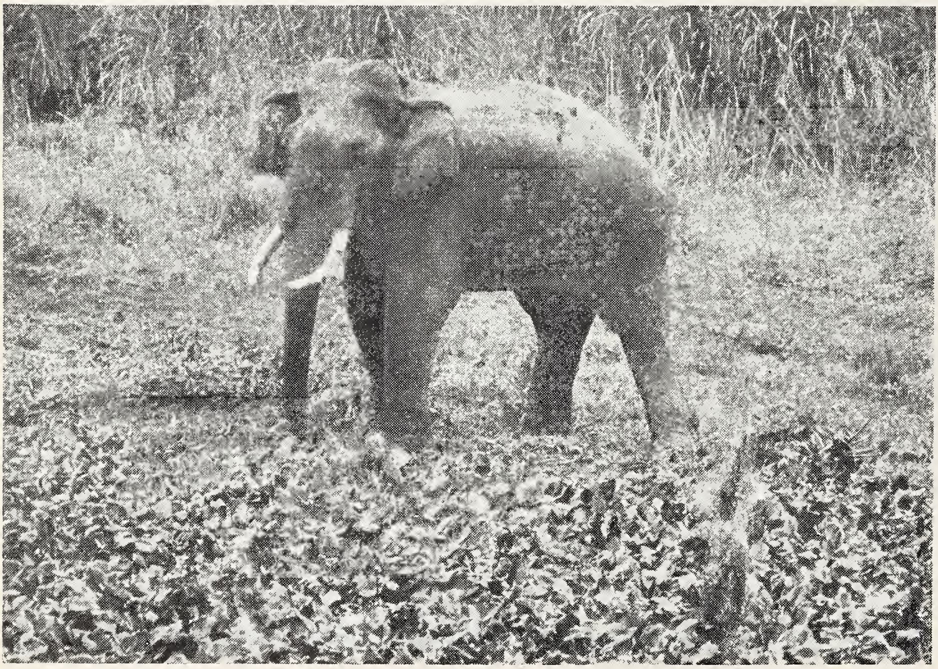


Above : KERALA 1970 : PERIYAR SA. : May 9 — a.m. : Herd of 20 elephants : Cow feeding on tree foliage — K. 41 ; *Below :* KERALA 1970 : PERIYAR SA. : May 10 — p.m. : Cow and calf scenting us — K. 43.

(*Photos: M. Krishnan*)

Krishnan : Mammals

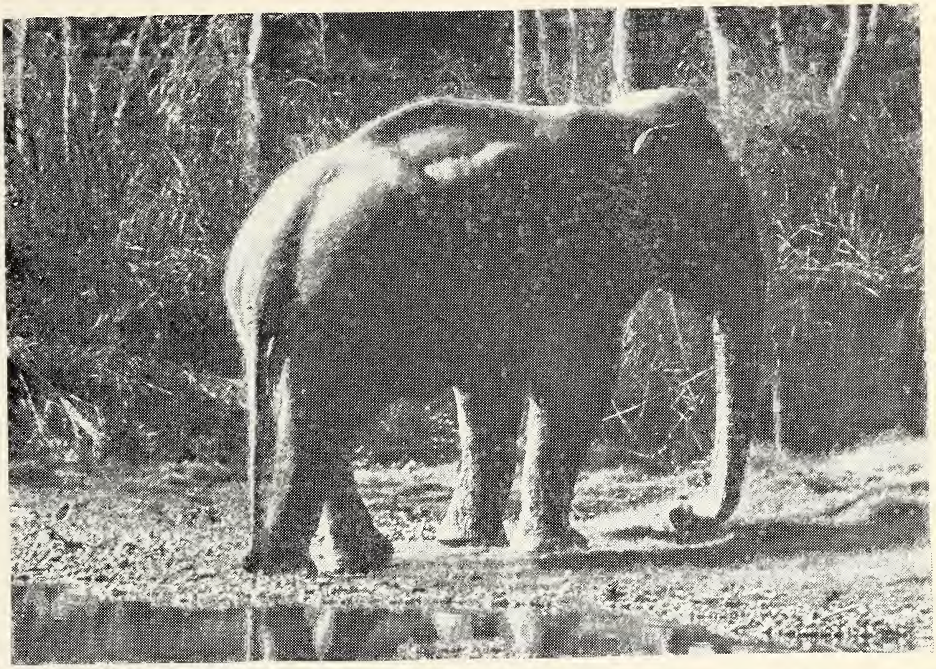


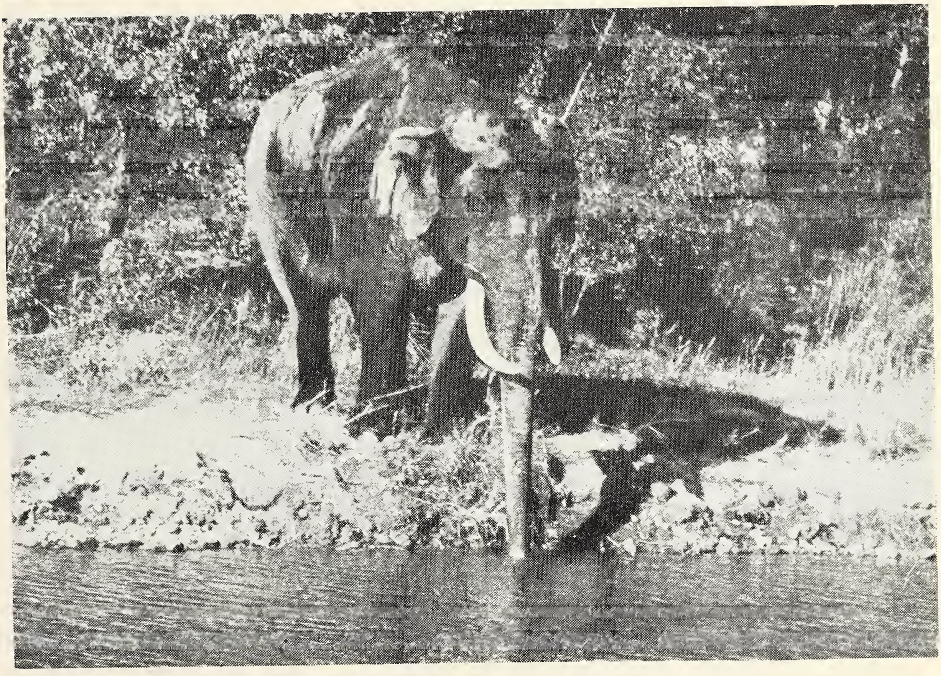


Above : MISCELLANEOUS : Jaldapara, WEST BENGAL : 1965 October 22 — a.m. : The Killer of Shibji — MISC. 2 ; *Below :* MISCELLANEOUS : Kaziranga, ASSAM : 1965 February 4 — p.m. : Tusker eating water hyacinth at Bimoli bheel — MISC. 3.

(*Photos : M. Krishnan*)

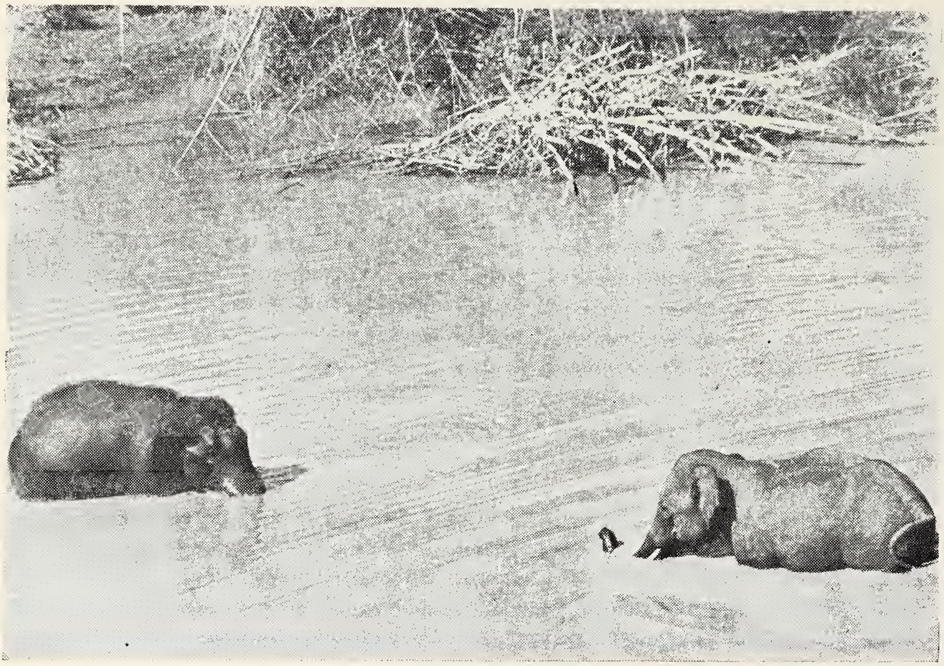
Krishnan : Mammals

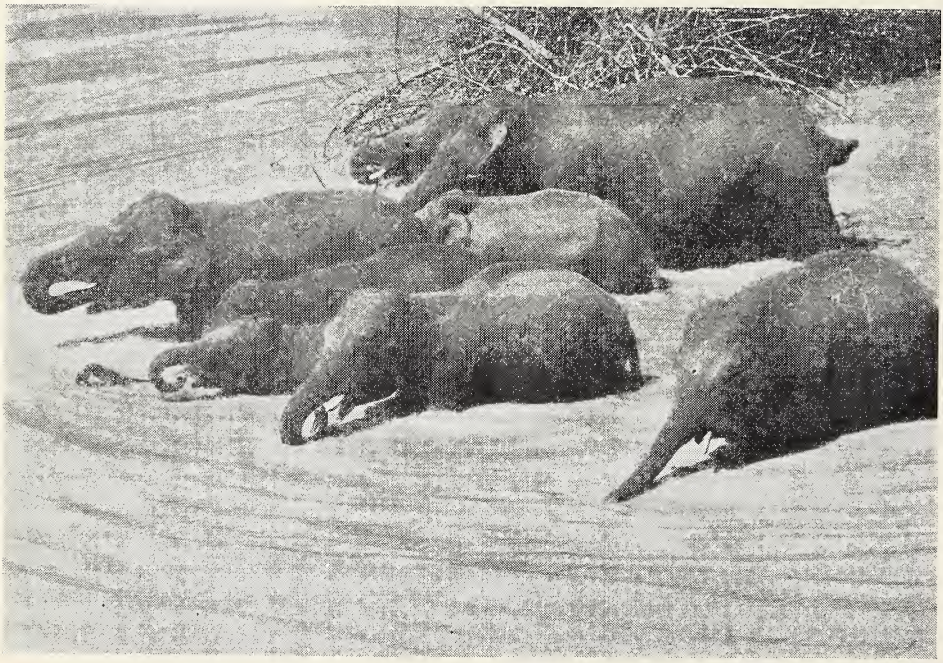




Above : MISCELLANEOUS : Kaziranga, ASSAM : 1968 February 10 — p.m. : The muckna at Bokani bheel — MISC. 4 ; *Below :* MISCELLANEOUS : Corbett National Park, UTTAR PRADESH : 1968 May 18 — p.m. : Tusker drinking at the Ramganga : Note extensile trunk — MISC. 5.

(*Photos : M. Krishnan*)

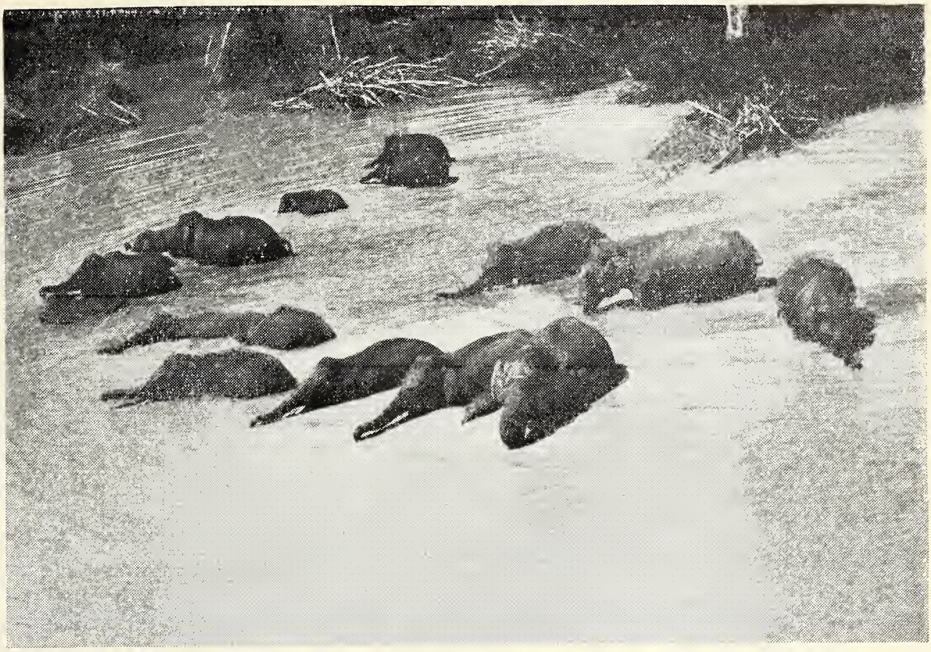


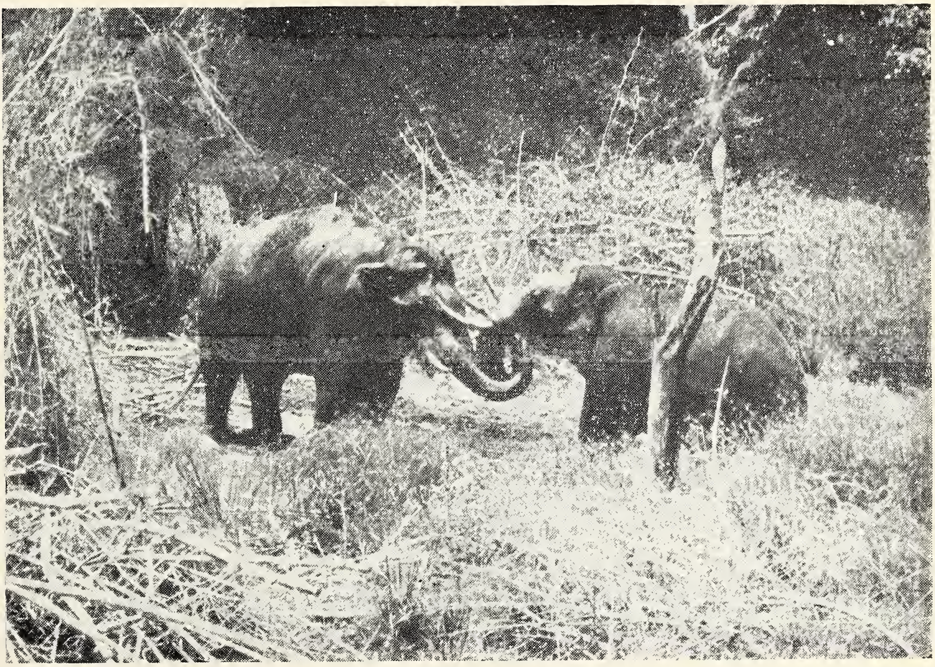


Above : MYSORE 1968 : BANDIPUR SA. : October 9 — a.m. : The 2 young tuskers in the water, Kollakumalikatté — MY. 3 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 9 — a.m. : Part of the herd entering the water, Kollakumalikatté — MY. 4.

(*Photos : M. Krishnan*)

Krishnan : Mammals

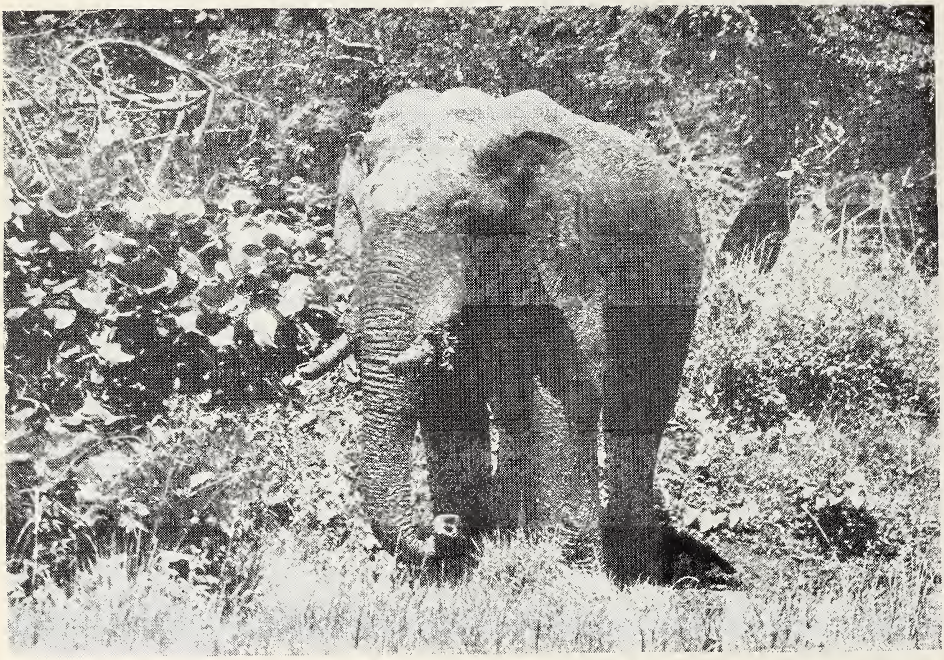


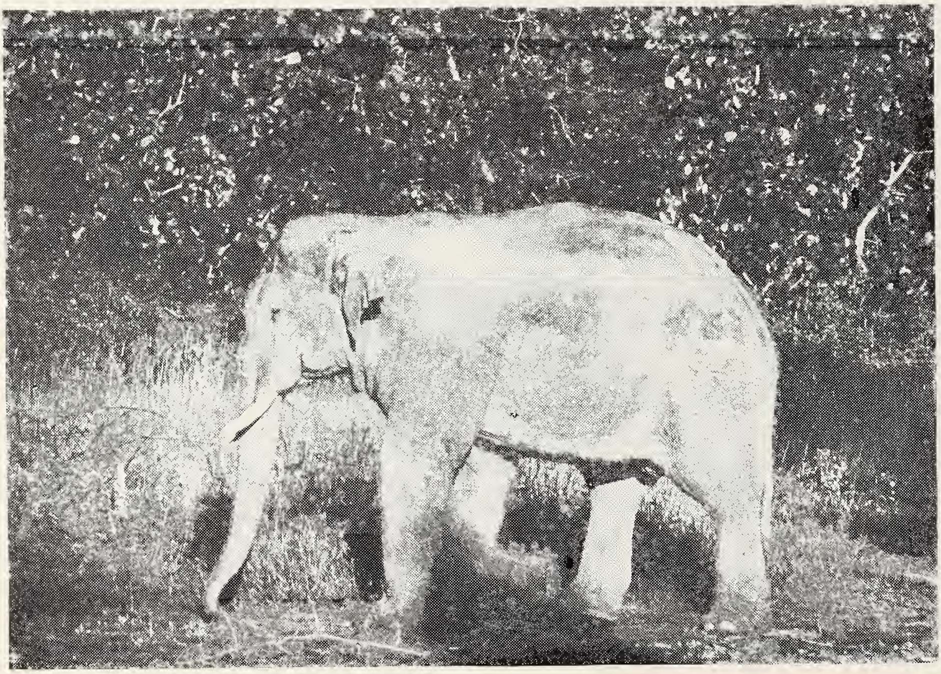


Above : MYSORE 1968 : BANDIPUR SA. : October 9 — a.m. : The herd in the water spreading out in a semi-circle : Note outreaching trunks — MY. 5 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 11 — a.m. : Blunt-tusks and sharp-tusks — MY. 7.

(*Photos : M. Krishnan*)

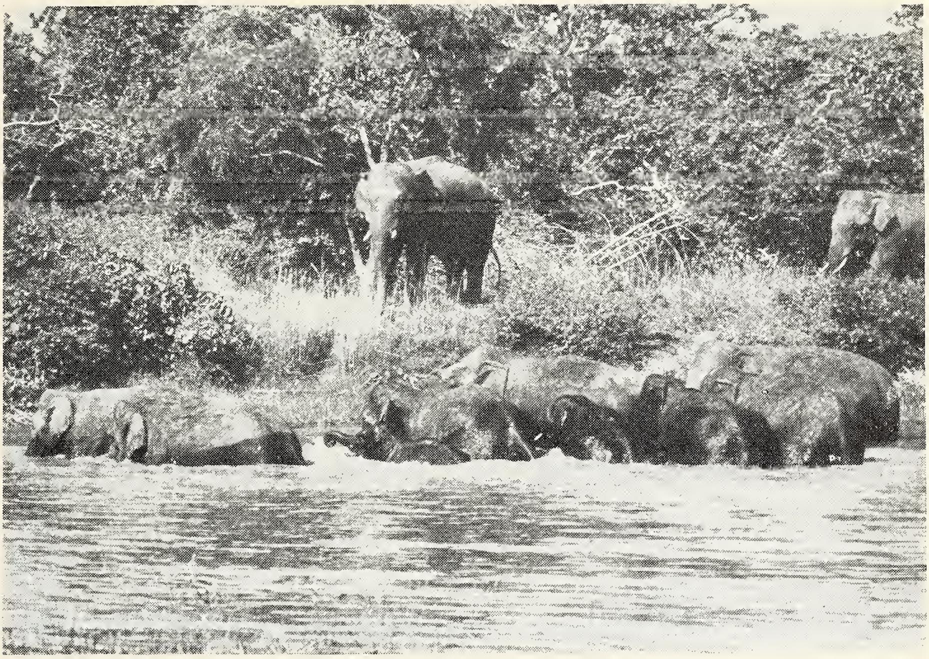
Krishnan : Mammals

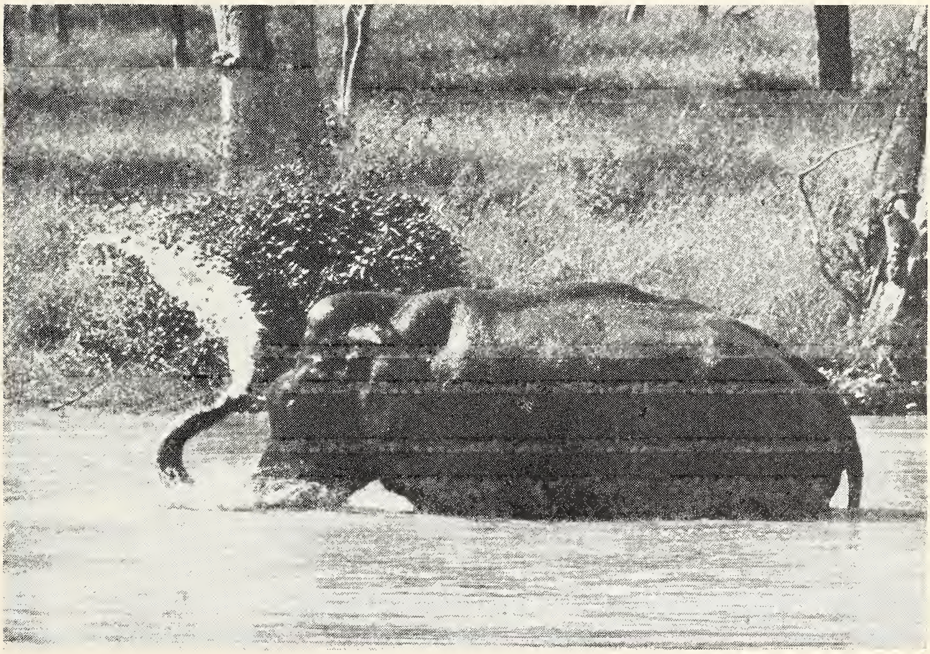




Above : MYSORE 1968 : BANDIPUR SA. : October 14 — p.m. : Tusker covered with mud, near Yerekatté — MY. 9 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 21 — 5.15 p.m. : The tusker that followed our ground-scent to Sullukatté — MY. 10.

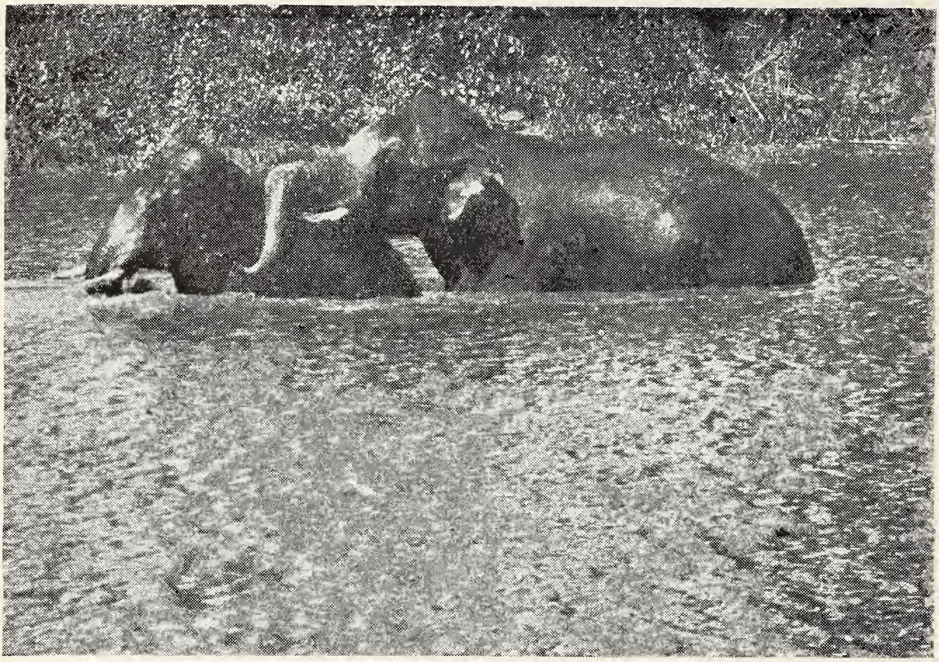
(*Photos : M. Krishnan*)

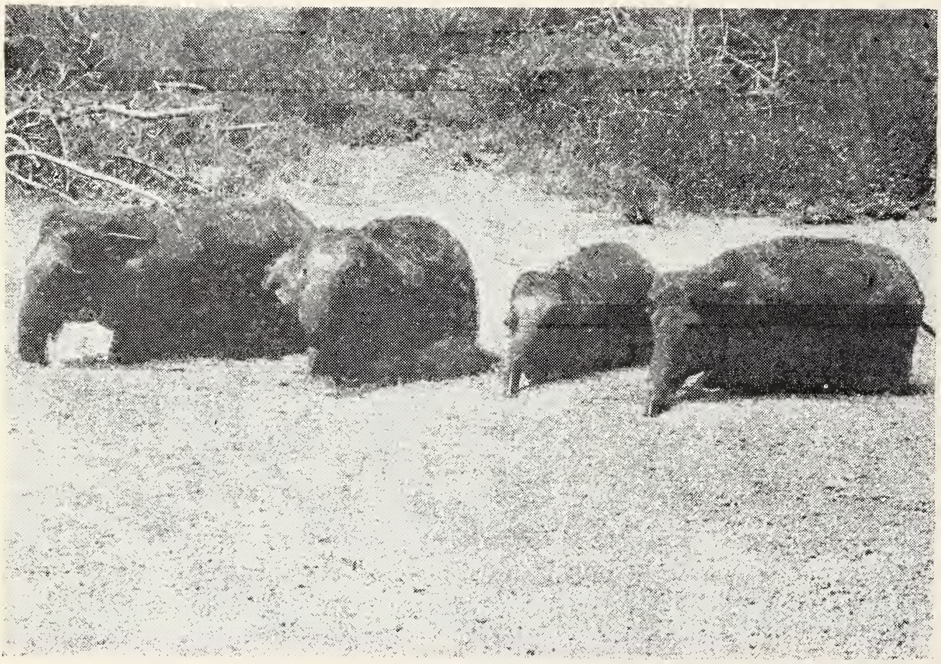




Above : MYSORE 1968 : BANDIPUR SA. : October 25 — 2.15 p.m. : Elephants bathing in Yerekatté — MY. 16 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 25 — 3 p.m. : The koomeriah in Kollakumalikatté. Note outwardly directed spout from the trunk and the ridge of water thrown up by the downward slap with the tusks — MY. 17.

(*Photos : M. Krishnan*)

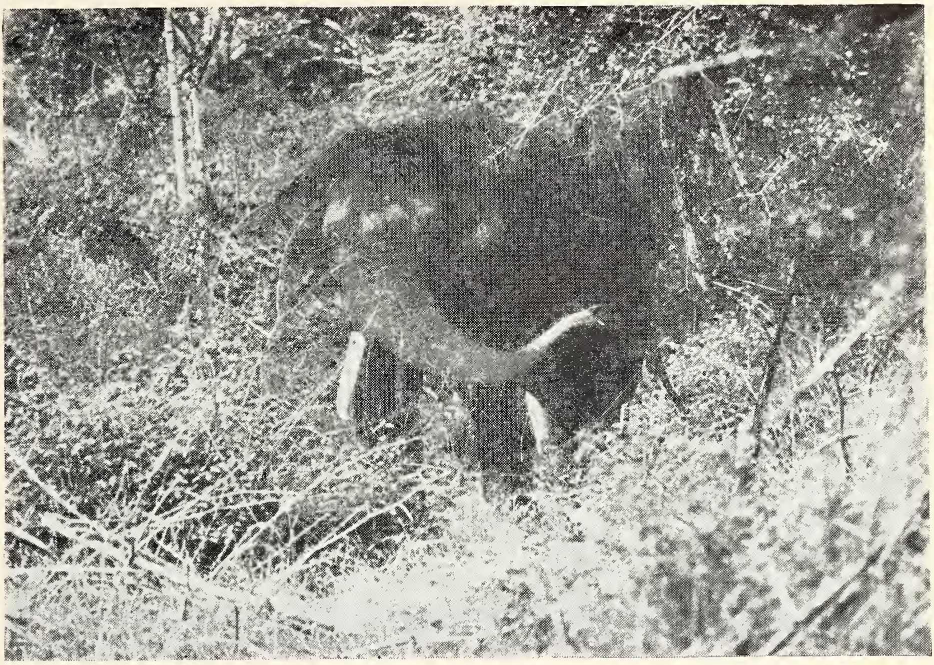


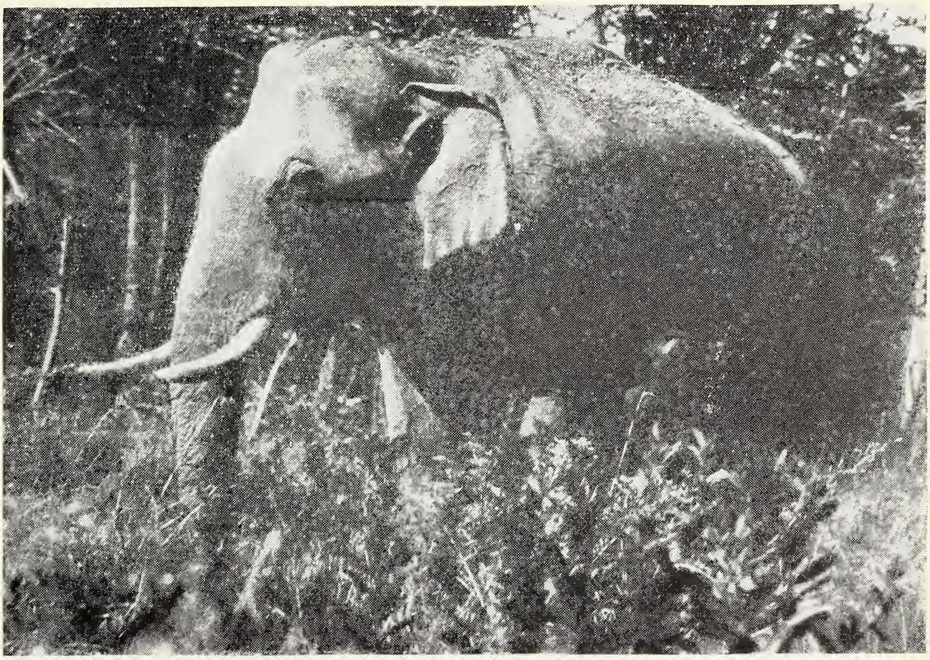


Above : MYSORE 1968 : BANDIPUR SA. : October 26 — 10.15 a.m. : The 2 tuskers in Tavarakatté — MY. 19 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 10 — 11.30 p.m. : 4 cows and a young calf in Kollakumalikatté — Note duckweed — MY. 22.

(*Photos : M. Krishnan*)

Krishnan : Mammals

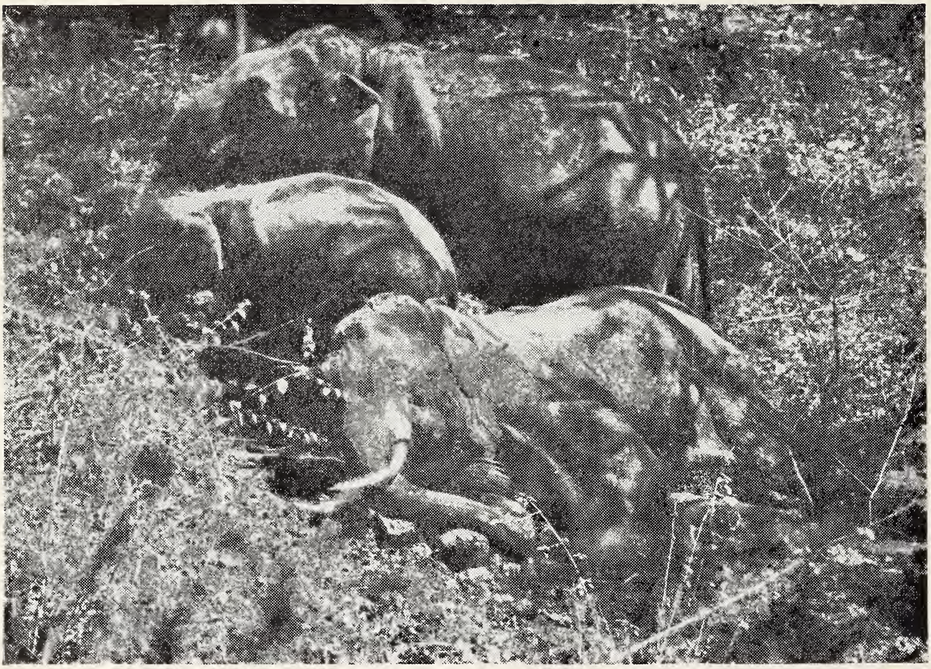


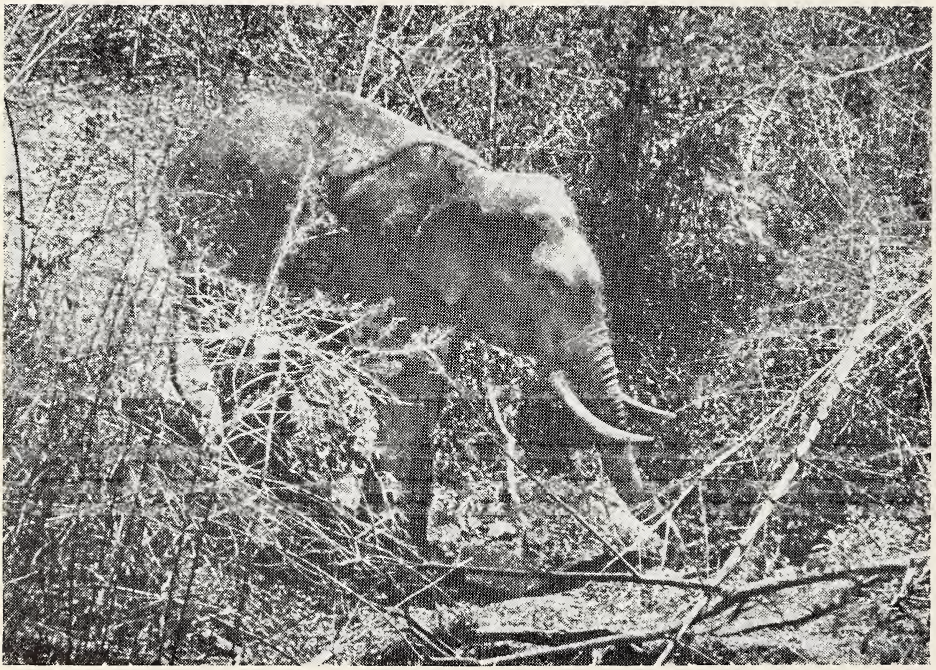


Above : MYSORE 1969 : BANDIPUR SA. : October 11 — a.m. : Lone tusker feeding on twigs — MY. 23 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 25 — a.m. : Big lone tusker near road to Moolapura — MY. 35.

(*Photos : M. Krishnan*)

Krishnan : Mammals

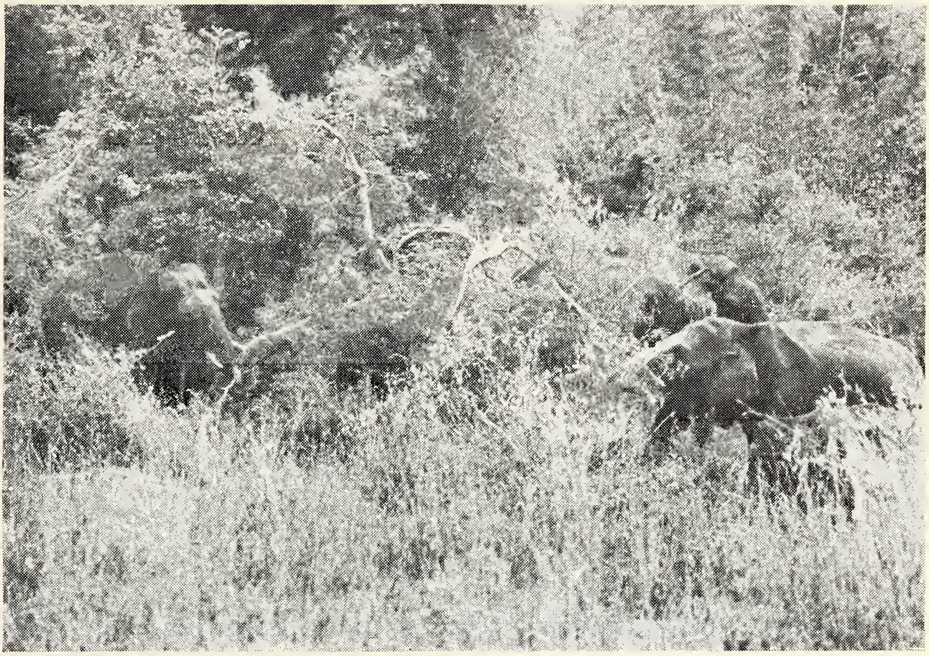


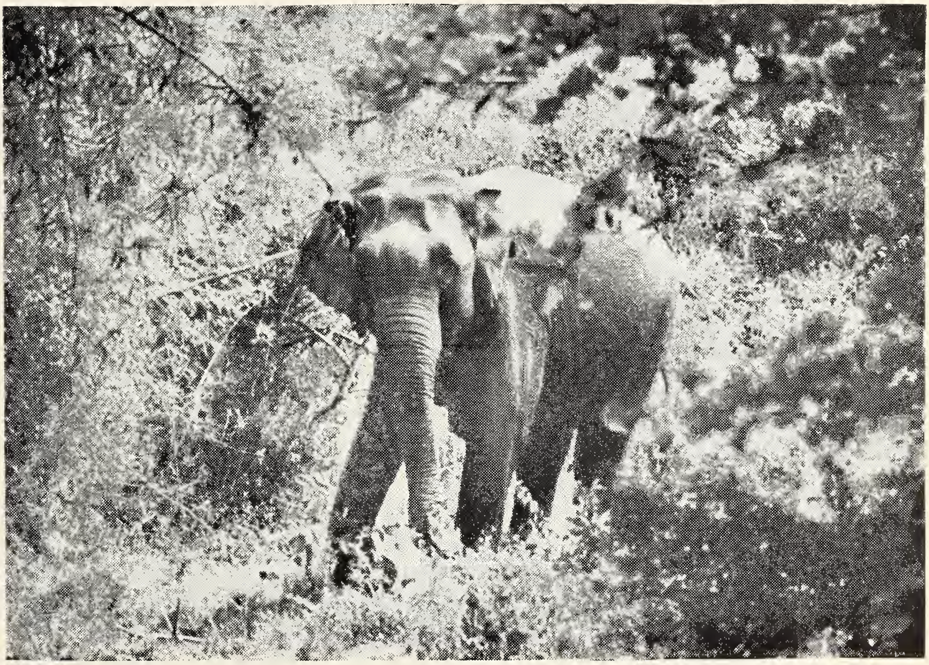


Above : TAMIL NADU 1959 : MUDUMALAI SA. : Benne : March 30 — noon : Tusker having a mud bath — TN. 5 ; *Below :* TAMIL NADU 1959 : MUDUMALAI SA. : Benne : March 30 — past noon : Tusker drinking at a water-hole — TN. 6.

(*Photos : M. Krishnan*)

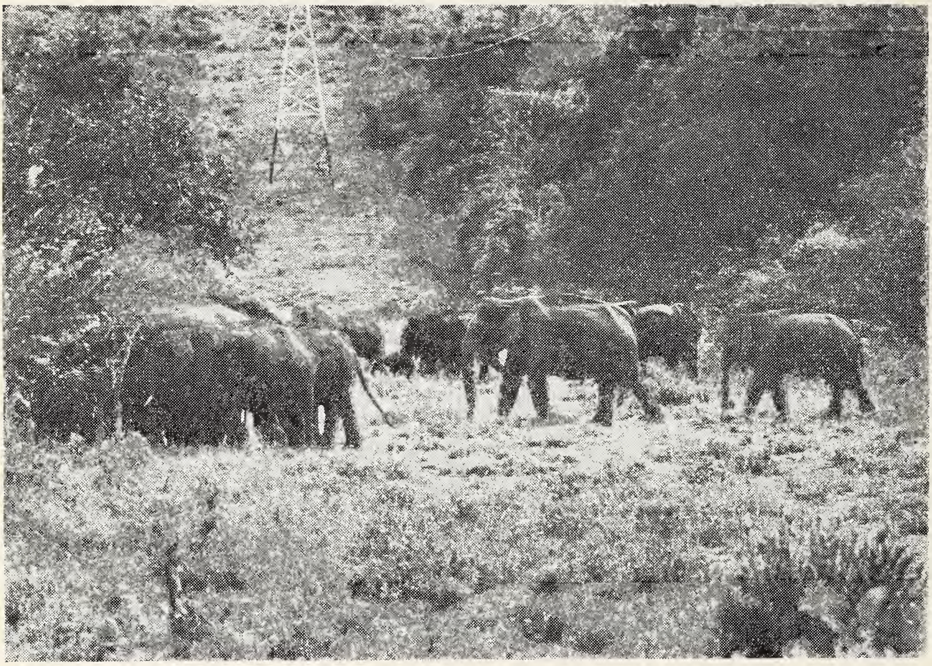
Krishnan : Mammals

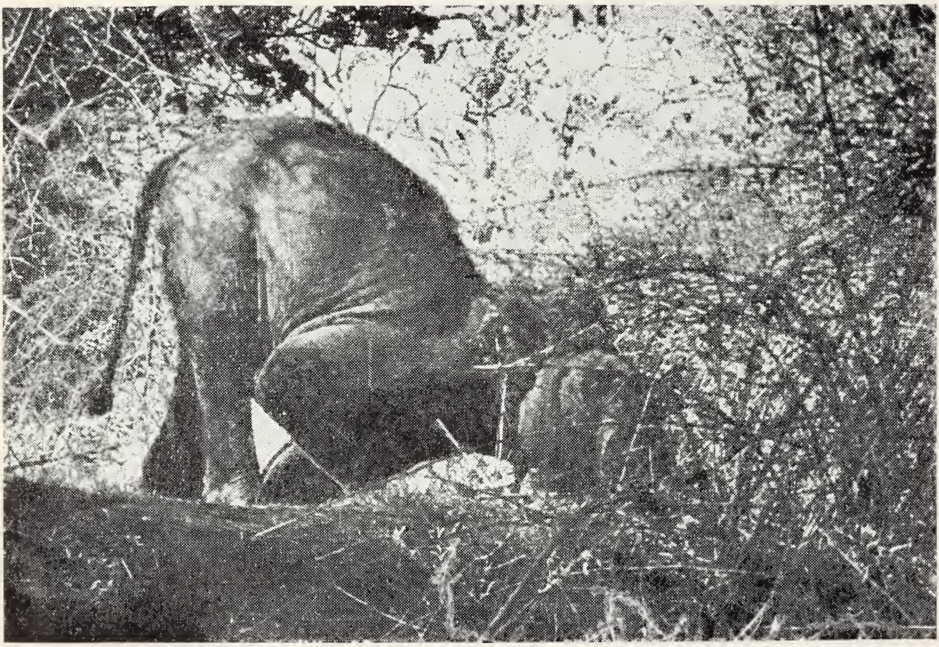




Above : TAMIL NADU 1963 : MUDUMALAI SA. : Masinagudi : September 19 — a.m. : Elephants feeding on an *Albizzia odoratissima* — TN. 27 ; *Below :* TAMIL NADU 1963 : MUDUMALAI SA. : Masinagudi : September 19 — a.m. : The cow that followed me by scent like a bloodhound — TN. 28.

(*Photos : M. Krishnan*)

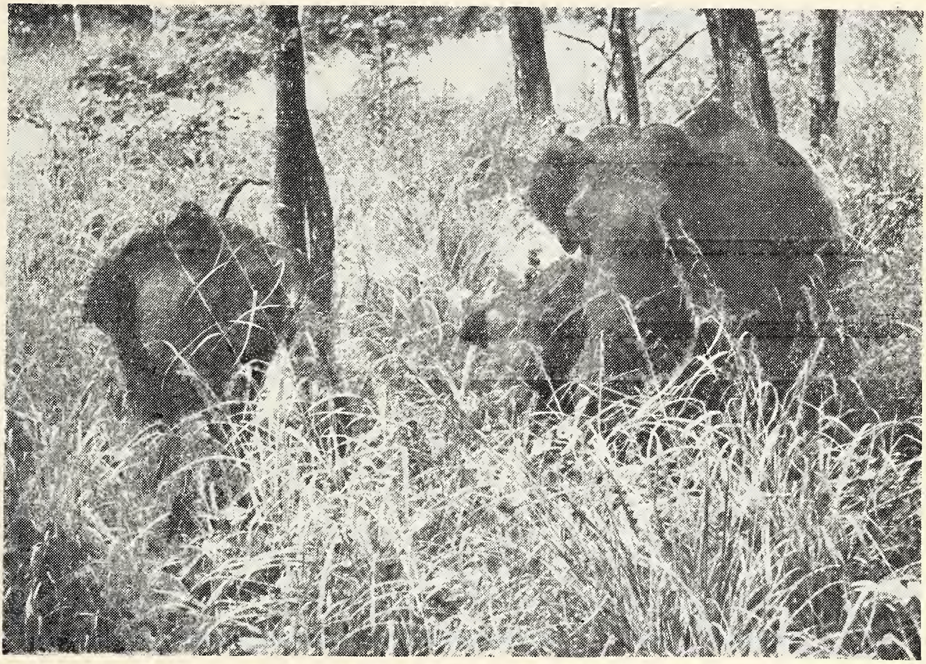


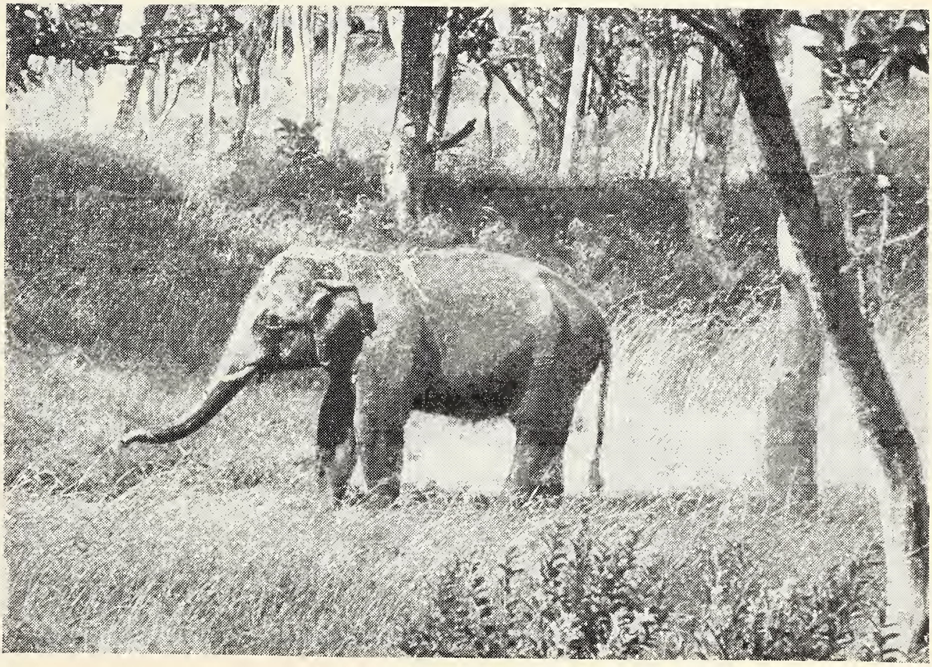


Above : TAMIL NADU 1963 : MUDUMALAI SA. : Masinagudi : September 20 — near noon : Electricity comes to Elephant Country — TN. 29 ; *Below :* TAMIL NADU 1964 : MUDUMALAI SA. : Theppakkadu : March 25 — a.m. : Tusker demonstrating by goring a bamboo clump — TN. 33.

(*Photos : M. Krishnan*)

Krishnan : Mammals

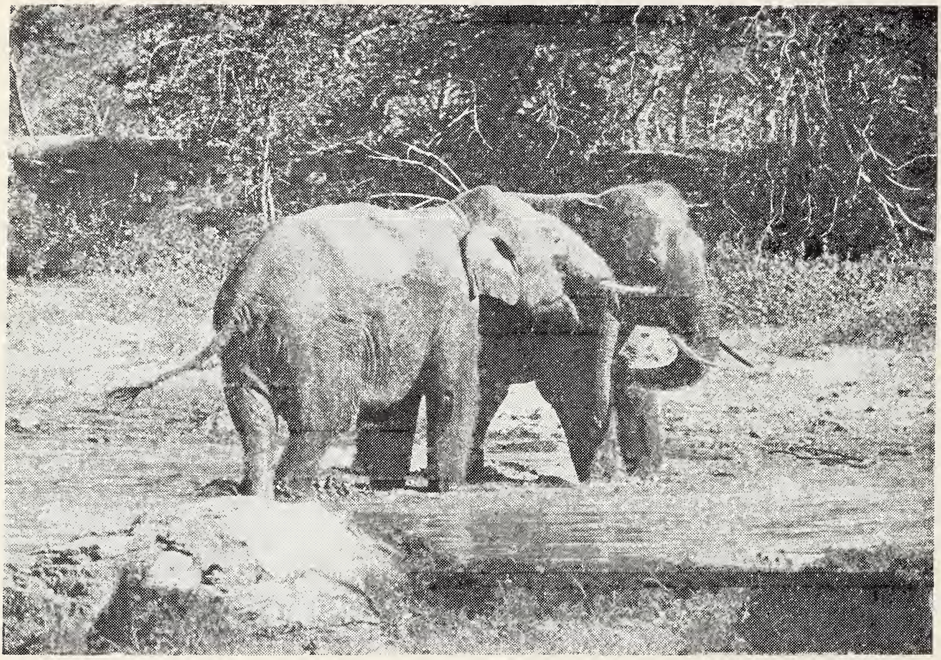


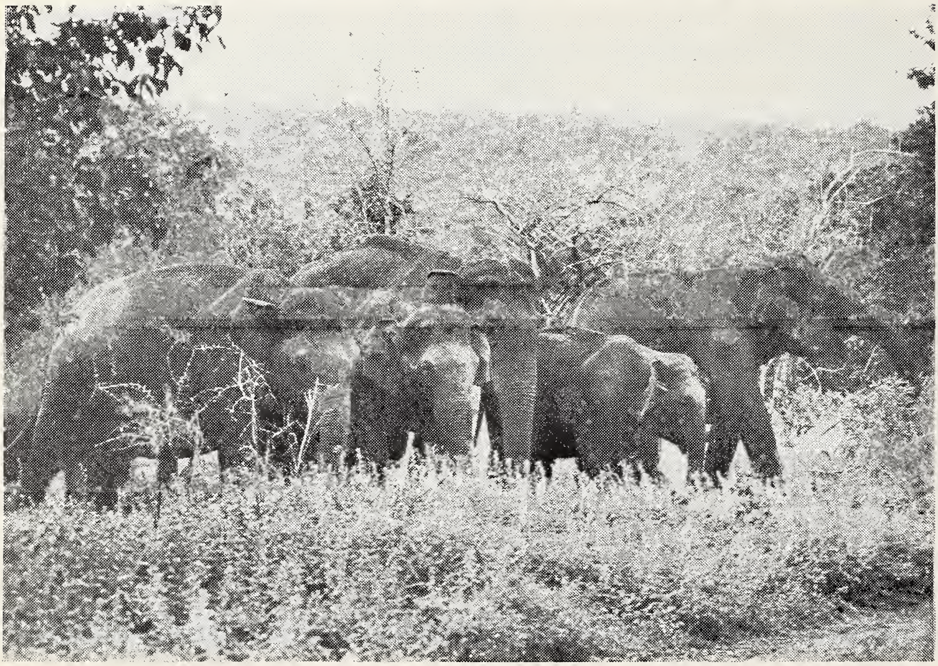


Above : TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : September 18 — p.m. : The cow elephants (with a calf) that came for us — TN. 38 ; *Below :* TAMIL NADU 1969 : MUDUMALAI SA. : Kargudi : September 18 — 4 p.m. : Blunt-tusks of Bandipur, October 11, 1968 ? — TN. 51.

(*Photos : M. Krishnan*)

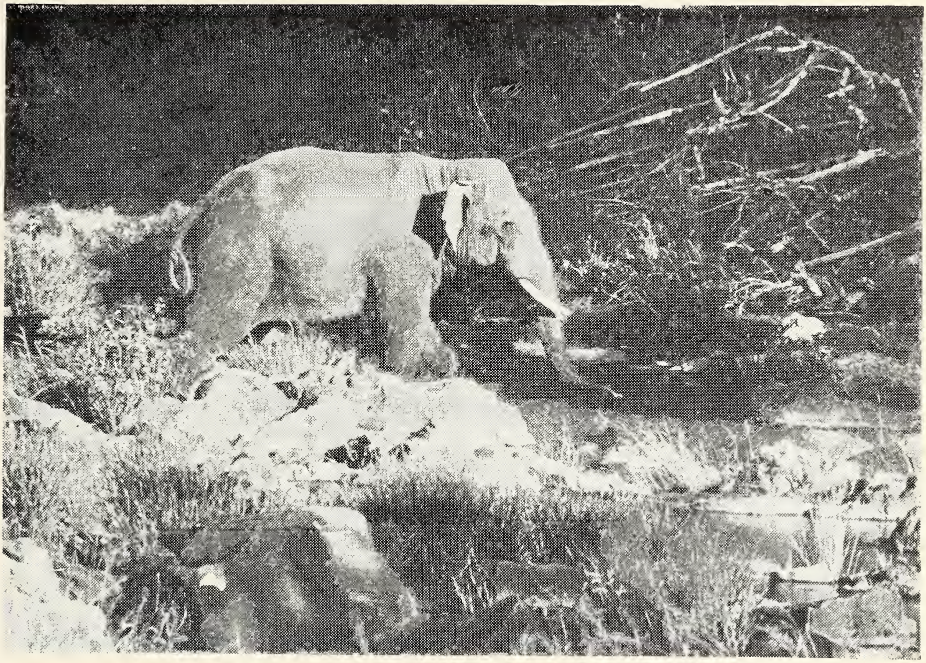
Krishnan : Mammals

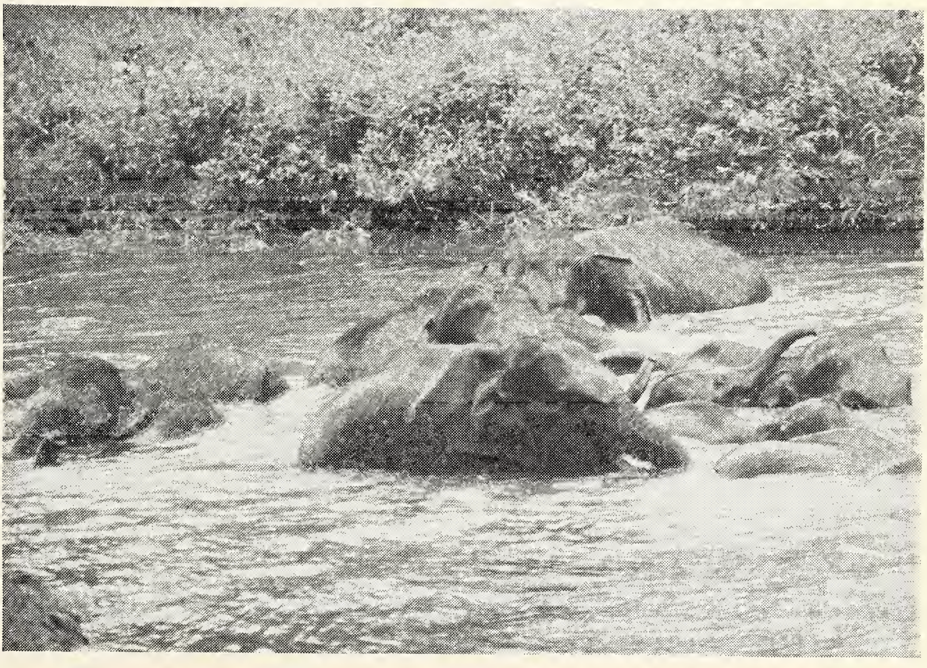




Above : TAMIL NADU 1969 : MUDUMALAI SA. : Masinagudi : September 24 — near noon : The 2 tuskers by the pool — TN. 52 ; *Below :* TAMIL NADU 1969 : MUDUMALAI SA. : Masinagudi : October 5 — p.m. : The herd approaching the road — TN. 56.

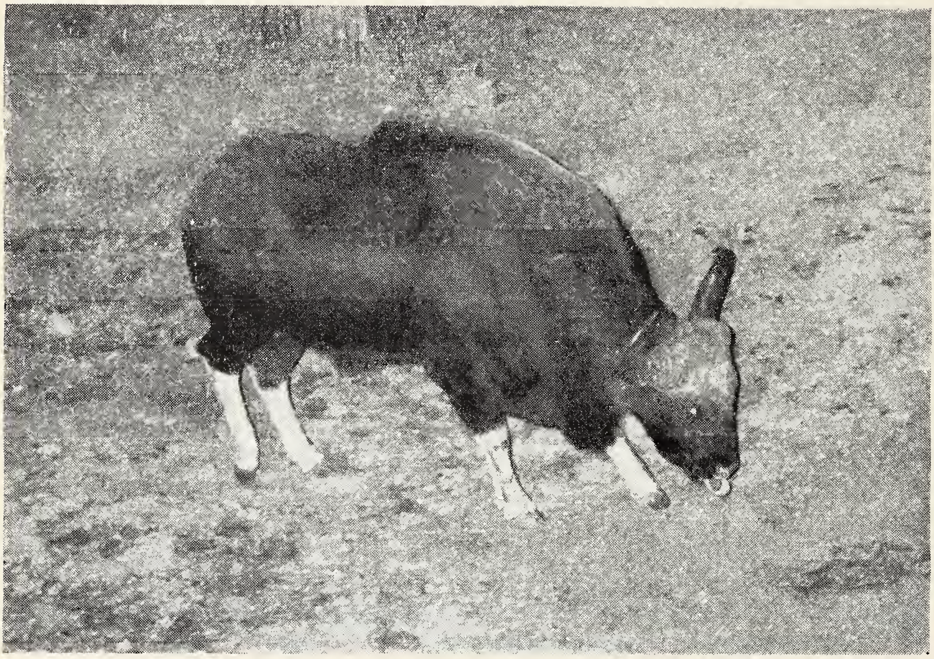
(*Photos : M. Krishnan*)

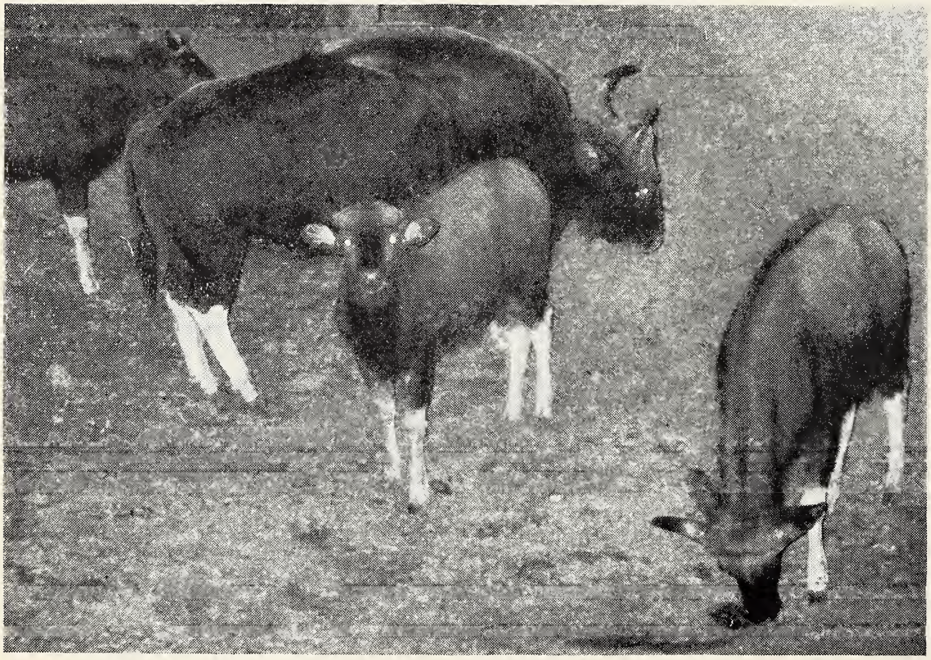




Above : TAMIL NADU 1970 : MUDUMALAI SA. : Theppakkadu : September 28 — p.m. : The lone bull at the Moyar — TN. 61 ; *Below* : TAMIL NADU 1970 : MUDUMALAI SA. : Theppakkadu : September 29 — p.m. : The party of elephants bathing in the Moyar — TN. 62.

(*Photos : M. Krishnan*)





Above : BIHAR 1969 : THOLKOBAD : Ligirda watch-tower : Night of February 3/4 — The bull with the brassy voice licking salt — B. 3 ; *Below :* BIHAR 1969 : THOLKOBAD : Ligirda watch-tower : Night of February 3/4 : The same bull in the previous picture with 3 subadults — B. 4.

(*Photos : M. Krishnan*)

a pink tinge to the grey. However the colour of a wild elephant is exceedingly difficult to judge, because the colour of the animal is so often that of the earth it has been throwing over itself—even a bright red elephant may be seen (K 70 May 5). Fresh from a bath, before they have dusted themselves with earth or thrown mire over themselves, elephants appear a gleaming black, and the lighter colour of an animal in the herd is then easily noticed. Some animals are definitely and noticeably light grey in colour (photograph TN 29; K 70 Apr. 22—photograph K11).

Calves up to the first 6 months of their lives may be covered with brown hair, not in a regular coat but in a loose tomentum. The colour of this hair may be quite light at times, a warm, yellowish grey, and may give the calf a light-coloured appearance. However this hair is not retained and such calves usually grow up into dark grey animals. The reports of 'white elephants' heard occasionally are based on people seeing such calves (TN 70 Oct. 5). No authentic white elephant (i.e. a notably light-skinned animal, a creamy-grey in colour with some pink in places) has been recorded within the peninsula.

In many adults, especially in old bulls, there may be much light pink speckling on the face, trunk and ears: the tip of the trunk is usually entirely pink in such animals (K 60 Apr. 10—photograph K6; K 70 May 6—photograph K 29, K 30). Sometimes a lacing of light pink may form a conspicuous border to the lower edge of the ears (photograph K 5: K 70 Apr. 22—photograph K 10).

Distribution

Prater gives the distribution as 'the forest-clad portions of India, Ceylon, Burma' and nearby countries. In Peninsular India, broadly speaking, the elephant is absent from Andhra Pradesh, Maharashtra and Madhya Pradesh, though these States hold many forests, especially hill-forests of the kind that elephants favour. There are wild elephants in Kerala, Mysore, the areas of Tamil Nadu adjacent to these 2 States, the interior hill-forests of Orissa, and parts of Bihar. In these States, elephants occur in broad belts of montane and submontane forests which have territorial and floristic continuity though politically they may be divided: for example, in the South elephants are found along the Western Ghats and associated hills and foothill forests.

Formerly, about 1000 years ago, there were extensive plains forests in the southern parts of the peninsula and elephants were found in such forests as well. The invasion of these areas by men and their conversion to human uses have driven away the elephants from the plains in many such places. To comprehend the changes in the distribution of elephants and other large forest-living animals (like gaur), which are gregarious and free-ranging, it is not enough to take note only of the physical changes that have overtaken their known former homes and the causes that have led to their local extinction in places: such animals are unable to stand the disturbance of frequent human intrusions into their haunts, and therefore leave them if the disturbance is sustained. Place-names such as Anamalais and Kunjaramalai testify to the elephant's love of steep, forested hills.

Habits: Behaviour

Much of the daily activities of elephants centre around the two main features of their life: they need quantities of fodder (estimated at about 500 lb. of green fodder per adult) to sustain their great bodies, and half their time is spent in feeding, and they are highly gregarious and reassemble periodically after getting split up in the course of their search for food.

Although the largest and most massive of land animals, their peculiar build and anatomy enable them to ascend steep slopes, and they are remarkably expert at climbing hills (K 70 Apr. 20). There are few hills in the south whose tops are not marked by regular, well-defined elephant-walks: these are not just the tracks of a herd that has recently passed that way, but the well-tamped paths used and re-used by a succession of elephants: these paths always follow the easiest and safest gradients, and an expert engineer planning the best routes up and down a hill cannot do better than follow these elephant-paths. It is noteworthy that at times such paths follow the very edges of hilltops, with a sheer fall of a hundred feet or more to one side—elephants are exceptionally sure-footed and apparently never suffer from vertigo.

It is said that the fastest pace of an elephant, as when charging, is a fast walk or shuffle and that the animal cannot run. Even G. P. Sanderson, whose knowledge of elephants was extensive, deep and authentic, and whose authority still sustains many passages in recent books (for example, Ivan T. Sanderson's THE DYNASTY OF ABU) has fallen into the error of supposing that elephants cannot run: he says, 'the only pace of the elephant is the walk, capable of being increased to a fast shuffle .... it can neither trot, canter nor gallop'. In the latter half of this statement he is perfectly correct—an elephant cannot trot, canter or gallop for the same reason that a man, when running naturally, does not trot, canter or gallop. The anatomy of the elephant is peculiar in that it has no hock as other quadrupeds have, but a true knee, like the human knee, that bends back. Therefore the elephant runs without leaping into the air, but it has two paces definitely, the walk and the run (TN 63 Mar. 24).

A consequence of their great bodily bulk is that they are virtually unsinkable, but they do not ride high in the water. They swim almost submerged, or just below the water, and the advantage of this when the surface currents are strong is obvious. (K 59 May 19, 70 Apr. 22 & 23—photographs K 13, K 17). G. P. Sanderson records that a batch of 79 tame elephants he despatched across the tidal creeks of the Ganges were in the water for six hours without touching bottom in one swim, and that in the course of this and three other long swims not one was lost. He rightly observes that 'full-grown elephants swim perhaps better than any other land animals'. The very young calves are at times reluctant to take to the water and are pushed in by their mothers or 'aunts' (K 59 May 19). In the water, young calves are helped by the support and guidance of the trunks of their mothers. G. P. Sanderson observes that older calves sometimes scramble on to the shoulders of their mothers during a long swim, holding on with their legs: I too have observed this. In crossing a broad, swift-running river they choose both the point of entry along a path sloping gently down the bank into the water and the point at which they clamber ashore on the bank across the water (K 70 April 22 & 29—photographs K 13, K 14, K 18)—they have regular paths for getting into the water and out of it, even into and out of a small forest pool (MY 68 Oct. 9).

Elephants bathe in forest pools and rivers entering the water carefully, fanning out, and then rolling over in the water, frequently submerging themselves (K 60 Apr. 10, 11 and 17; MY 68 Oct. 9, 25 and 26, 69 Oct. 10; TN 69 Sep. 19, 70 Sep. 28 and 29; B 69 Feb. 26—photographs MY 3, MY 4, MY 5, MY 16, MY 17 and MY 22; TN 61 and TN 62; B 21). They are not found in places where there is no source of drinking water, for they drink every day though they may not bathe every day. Baths are also indulged in during the rainy season, even when it is raining. A small water-hole may suffice to provide drinking water (TN 59 Mar. 30—photograph TN 6). They drink by sucking water up their trunk and then squirting it down their throats. The process seems reversible in a small measure. It is well known that, when feeling hot, an elephant will insert the tip of its trunk into its mouth, bring out some fluid and spray it all over itself. This fluid is not water from the elephant's stomach, as it is said to be: it is not acid and does not turn blue litmus red. It is probably saliva.

Elephants draw muddy water up their trunks and squirt it over themselves, muddying the water with a forefoot for this purpose if it is too watery (K 60 Apr. 4). Water is also squirted in a shower over the back and head, and directed in squirts at the belly and head—an elephant feeling hot, cools itself in this manner. Where semi-solid mire is freely available, as at drying pools, it is taken up in lumps in the crook of the tip of the trunk and flung over the back, head and flanks (MY 68 Oct. 11; TN 69 Sep. 23).

A regular wallow is also indulged in: this may be when it is dry and hot, as in summer, or when it is cool, as on an overcast day in

September or October (TN 59 Mar. 30, 69 Sep. 23; MY 68 Oct. 6, 14 and 18—photographs TN 5 : MY 9).

Dust-baths are usually taken soon after climbing ashore from water, the dust being drawn up the trunk and blown over the head and back (K 60 Apr. 3, K 70 Apr. 22 ; TN 63 Sep. 19—photograph K 10). Dust is also sprayed over wounds to cover them (K 59 May 20). Earth, and salt-earth, is kicked up by the forefoot, and eaten (MY 68 Oct. 26 ; K 70 Apr. 22 & 30; MY 68 Oct. 25—photograph K 21). There appears to be a tendency among gravid cows to eat earth.

Apparently all this dusting and mud-bathing and mire-smearing serves to relieve cutaneous irritation or to provide some cutaneous gratification: the way elephants revel in baths, dust-baths, wallows and mud-slinging does suggest such a purpose. Calves under six months do not indulge in dust-baths or squirt mire over themselves because by that age they have not acquired sufficient skill with their trunk to put that most versatile organ to such uses: however, they wallow in the wet mud and in muddy shallow water.

Elephants also rub themselves, both when their bodies are covered with wet mud and when their skins are dry and clean, against the boles of trees. For this purpose a thick tree is chosen, often with a slight lean from the perpendicular, and they rub themselves against the bole on the side on which the bole leans towards the ground : such rubbing trees, covered with mud from about 3 feet to 9 feet up their boles, are often to be seen in the neighbourhood of forest pools (MY 69 Oct. 16 ; K 70 May 9).

One big bull chose and detached a dry twig while having a mire bath, and then scratched himself over the flanks and back with the twig held in his trunk (K 60 Apr. 4). Another bull with maggot-infested gunshot wounds rubbed himself against a ventek bole to detach the maggots from his wound (TN 59 Mar. 21).

In feeding, while the trunk is used to detach and convey food to the mouth, the forefeet are also used as adventitious aids, to crush and break up large fruits and small branches or bamboo culms, and to dust grass against. Watching elephants feed, one is impresssed by the care with which they select and prepare each mouthful for ingestion: they are choosy feeders.

Fodder naturally varies with locality and season, and what follows is merely indicative of the many kinds of plant food they eat. They are entirely vegetarian, and while hard stems and twigs are also eaten, the bulk of their food consists of foliage and soft plant parts, or succulent herbs.

Many kinds of tall grasses (all those appropriately and loosely termed ' elephant grass ') are eaten, as also some short grasses and purely herbaceous plants. Among the grasses commonly eaten may be mentioned *Saccharum spontaneum*, *Ischaemum pilosum*, species of *Panicum*, *Sorghum* and *Themeda*, *Apluda mutica*, *Arundinella holcoides*, *Eragrostris gangetica*, *Hackelochloa granularis*, and *Paspalum scrobiculatum*.

Some sedges, and some plants of the Zingiberaceae such as *Costus speciosus* and *Alpinia* spp., are also commonly eaten.

All these grasses and succulents are torn out in a sheaf or bunch with the trunk, dusted vigorously, and placed crosswise in the mouth. This is a highly skilled operation to which we find no parallel in the feeding habits of other herbivores.

The sheaf is neatly packed before it is pulled out (the grasses usually by their roots): it is then dusted on the bent and raised wrist by being slapped sharply against it with a twirl of the trunk, or, especially when the bunch of fodder consists of short grasses with stolons or sedges, the trunk is formed into a double twist near its end and then violently untwisted in the air: this move generates considerable centrifugal force and the adherent mud and debris is sent flying away from the plant. When feeding in thick cover, when what is held in the trunk cannot be easily dusted against the foreleg, the trunk is raised high and the fodder swiftly twirled aloft to clean it. No doubt, in addition to clinging mud and dust and debris, the sheaf is freed of insects, snails and the like by these manoeuvres (TN 63 Sep. 19; K 70 May 6—photograph K 29—other observation notes and photographs, not reproduced here, support these statements).

The sheaf of grass is placed crosswise in the mouth, with the basal root part projecting from the lips on one side and the tips of the blades on the other; then, at a bite the projecting parts of the sheaf are bitten through and allowed to fall to the ground, and the rest is masticated and swallowed. When the grass is tender, the blades are consumed, and it will be found that the rejected parts of sheaves (which mark the passage of the animal in the course of its grazing) consist largely of the basal stalks and roots; when the blades are mature and hard, but basal culms are succulent, the apical part of the sheaf is rejected and the culms (with only the roots bitten off) consumed. The placing of the sheaf in the mouth and the consumption of a part of it is a selective action and not purely mechanical (TN 62 Mar. 15, 66 Apr. 23).

Bamboos (both of the genus *Bambusa* and *Dendrocalamus*) *Ochlandra* spp., and sugarcane and standing crops in fields are among the other grasses much fancied as food. In feeding on the giant bamboo, the entire clump is not pushed down: individual culms are selected, and these are either pushed down or pulled down, and then another culm is brought down. It is not only the foliage that is eaten, but also the culm. Elephants will, on occasion, eat even dry bamboo fallen on the forest floor. Ratan cane is much fancied and eaten thorns and all (MISC 68 Feb. 4). Banana plants are pulled down, the stem split open with the forefoot, and the 'pith' eaten—a noticeable preponderance of banana fibre in the dung betrays overnight raids on plantations (TN 64 Apr. 12).

E. P. Gee told me, in 1968, that when the water hyacinth (*Eicchornia crassipes*) first invaded the bheels of Kaziranga, the elephants and other wild animals would not touch it, but in 1968 I found buffaloes and rhinos eating the exotic weed occasionally, and elephants less occasionally (MISC 68 Feb. 4 : photograph MISC 3). It is known that this plant has a considerable iodine content; in fact, in an emergency it was utilised for the commercial manufacture of iodine. How far and in what ways the sustained intake (even in small quantities) of this iodine-rich plant will influence elephants (and other animals) is a matter which needs investigation.

Among the succulents eaten should be mentioned *Pandanus* spp. and *Ardisia solanacea,* both growing in brakes along forest streams: these provide a source of water even when the streams are dry in summer (TN 66 Apr. 15).

An exotic that seems to be more freely eaten now than some 25-30 years ago is lantana (TN 63 Sep. 19; TN 64 Mar. 21; TN 66 Mar. 30; TN 70 Oct. 4).

The bark of certain trees, such as *Kydia calycina*, *Grewia tiliaefolia* and teak, is skilfully stripped and eaten; it is not the dry bark that is eaten, but bark that is sappy, especially the bark of saplings. To strip the bark from the tree, the elephant applies the ventral aspect of the base of the trunk to the tree with a firm pressure and then jerks its head laterally; this causes the bark to split and get detached from the wood at that part, in a strip some 4 to 6 inches wide; the lower broken edge of the strip is then gently lifted up with the trunk till the bark is stripped as high as the trunk can go and hangs from the bole; then this strip of bark is held lax in the trunk and given two or three preliminary oscillations and then one quick upward flick, that detaches it for another 2 or 3 feet up the trunk. After eating this, another strip of bark next to the peeled strip is similarly peeled and consumed (TN 63 Mar. 24). It was noticed that in a *Kydia calycina* almost completely stripped of bark in 1963, by summer next year new bark had covered the wood (TN 64 Apr. 14).

Many shrubs and small trees are eaten, foliage and twigs together; among these may be mentioned *Helicteres isora*, *Grewia aspera* and other species, *Hibiscus lampas*, *Acacia concinna*, *A. intsia*, *A. ferruginea*, *A. catechu*, *Cordia myxa*, and *Zizyphus xylopyrus* (TN 63 Sep. 24, 64 Mar. 21, 66 Mar. 30, 69 Oct. 1; MY 69 Oct. 11—photograph MY 23).

Phoenix humilis is much liked, the foliage and the fruits both being avidly consumed.

In the South, it is not rare to come across *Buchanania latifolia* saplings in the forests that look as if they had been pollarded: wild elephants eat the crown of this tree when it is in new leaf, to give it this appearance. *Emblica* sp. and *Ficus mysorensis* and other species, *Premna tomentosa, Elaeodendron glaucum, Albizzia odoratissima* and other species, *Diospyros* spp. and *Bauhinia racemosa* are among the trees whose foliage is regularly eaten (TN 63 Sep. 19, 64 Mar. 21, 66 Mar. 31, 69 Oct. 1; MY 68 Oct. 20, 69 Oct. 11).

The aerial roots of the banyan are much fancied, and regularly broken off at the level of the elephant's reach, as they regrow (TN 69 Oct. 1).

I have seen elephants laboriously gathering and consuming the flower heads of *Mimosa pudica* (TN 59 Mar. 21, 62 Sep. 12). Flowers do not form any significant part of their diet, but they painstakingly collect tiny morsels that they specially fancy.

A variety of forest fruits are eaten, among them *Aegle marmelos, Artocarpus integra* and *A. hirsuta, Careya arborea, Cordia myxa, Emblica* spp., *Feronia elephantum*, figs, *Pandanus* sp., and *Randia uliginosa* (TN 64 Apr. 5; B 70 Feb. 26). The grain of seeding bamboos, and the seeds of *Cycas* are eaten.

The substantial part of the food of elephants consists of grasses, sedges, other herbaceous plants, and bamboos.

Young calves subsist on their mother's milk up to the age of about 6 months, when they begin to feed on grasses and herbs. They may be suckled occasionally till they are 3 years old. A young calf is singularly clumsy with its small, undeveloped trunk, which it lays against the axilla of its mother while sucking milk (K 70 May 1—photograph K 25), and it is only as it grows up that the trunk develops and it acquires skill in the use of the organ. The breasts of a cow elephant have a slight outward lean, towards the flank, and this facilitates suckling the calf (photograph K 38).

Elephants and gaur are usually found in the same forests, and it has been said that they feed amicably together. This has not been my experience. No doubt gaur benefit by following in the wake of elephants, and consuming the bamboo and other tree foliage pulled down by the latter, but elephants do not allow gaur to feed along with them (TN 62 Apr. 10). In their feeding, they keep in a group or feed by themselves, and are quite unsociable. They do not like the company of other animals even at forest pools and drive them away, or where the water is tainted by other animals having drunk at the same pool, scrape fresh water-holes for themselves with their feet (TN 69 Sep. 23; B 69 Feb. 26).

In its period of infancy and growth to adolescence and maturity, and in its longevity, the elephant bears striking points of resemblance to the totally unrelated human being. A cow elephant may be said to be adult at 16 years of age, and is capable of breeding then, though still not full-grown, and a young bull at 20. Gain in height, and especially in substance, continues till the animal is 30: it is in its prime from 30 to 40, middle-aged from 45 to 55, and definitely aged at 60, though it may be often quite robust still. Cow elephants continue to breed till about 55 years old, and seek the society of bulls even when past 60 (TN 70 Sep. 23, 27 and Oct. 3).

In recent years, doubts have been expressed by some foreign writers on the elephant really being a long-lived animal, and it has been said that it does not live to beyond 70 years. No doubt it exceeds this classical span of three-score-and-ten on occasion, even as men do, when free and wild. Anyone who has some knowledge of wild elephants in India will appreciate how much better conditioned than tame elephants they are, and how much less subject to wear. G. P. Sanderson has argued this point ably.

The periodic occurrence of musth in adult elephants, marked by a dark, oily exudation from a temporal gland with a pore on either side (roughly midway between eye and ear) and a tender swelling of the temples and forehead, is something peculiar to elephants and its full significance is not yet known (photographs K 5, MISC 2). Little that is an original addition to what G. P. Sanderson wrote about musth a century ago is available in the literature on *Elephas maximus.* Musth does seem to have some sexual significance, though it is not, as popularly supposed, merely an expression of abundant virility. Musth afflicts old elephants as well, and some animals in musth are in very poor condition—in what follows, the manifestation and consequences of musth in tame elephants have been left out of reckoning as so many artificially-imposed conditions supervene then that it is not safe to draw any conclusions from the behaviour of tame elephants when in that condition. Almost invariably, it is an adult bull that gets into musth, but in rare cases a cow may do so. G. P. Sanderson records two instances of cows in musth, ‘ in newly-caught females in the prime of life, and in very full condition ’. During the long period of pregnancy (one of the longest among all mammals), before a cow is far gone in calf, she does often give the impression of being, not obviously pregnant, but in very full condition. All the cow elephants I have seen in musth were probably pregnant: of the 2 observed within the survey period (B 69 Feb. 19 *et seq.*; K 70 Apr. 22—photograph K 11), one was heavily and patently pregnant, and the other was very probably pregnant, appearing to be well-fleshed and in full condition. It could be that the rare incidence of musth in cow elephants is in some way related to pregnancy.

Bulls in musth often exhibit a marked lethargy, as remarked by Sanderson ; this lethargy does not manifest itself in immobility or slowness of movements, but in a marked indifference to the surroundings—a bull in musth often appears to be in a state of somnambulance, though its stride is not shortened. This, however, is not an invariable feature of musth. Some bulls in musth observed were wide-awake and even aggressive, for example a tusker in West Bengal (MISC 65 Oct. 22—photograph MISC 2), a muckna in Assam (MISC 68 Feb. 10—photograph MISC 4) and a tusker in Mysore (MY 68 Oct. 9 and 25—photograph MY 17)—the last, when first seen, was in a highly excited state. Other elephants in musth have exhibited that somnambulistic indifference to their surroundings that made it possible to approach them closely for a picture (K 60 Apr. 10—photographs K 5 & K 6 : MISC 68 May 18—photograph MISC 6 : TN 70 Sep. 27). In a party of elephants it was noticed that the cows were attentive and considerate to the tusker in musth (TN 59 Mar. 30). Bulls in musth frequently squirt water over their swollen musth glands and forehead, and apparently the lavage serves to unclog the musth pores (photograph K 6). A tusker in musth invaded the elephant camp in Kargudi (in the Mudumalai Sa.) and mated with a cow that was in season—his aggressiveness towards men was not caused by his condition, but due to his resentment of being closely watched by crowds, and shouted at (TN 64 Mar. 22, 25 & 28).

A peculiarity noticed in tuskers in musth is that they often carry tight-packed clay on their tusks, so closely adherent that even a swim in fast-flowing water does not wash it away (K 60 Apr. 10—photograph K 6). This adherent clay is acquired when the tusker gores earth banks and even the clayey bottoms of forest pools while in musth : this goring is not something done in a frenzy, but evidently indulged in to cause the free outflow of musth from the temporal glands by the pressure imposed on the swollen glands by the goring (MY 68 Oct. 25 : MISC 68 May 18). The duration, periodicity and heaviness of affliction of musth all vary with individuals, and even from one bout to another in the same individual. At times the exudation is thin and at times so profuse that it stains the entire cheek and runs down the face.

As among most herbivores, the sexual act occupies only a very short time, less than a minute (TN 64 Mar. 30–a.m.), but the love-play preceding it is elaborate : coition is usually repeated many times during three or four days the bull and cow are together—even when in a herd, the pair are seen by themselves when the cow is in season and has accepted a bull (K 60 Apr. 5). The belief held by many professional elephant men that the cow decides with which bull she will mate seems to be factually sound, although it is also true that rivalry among adult bulls may become acute when a cow is in season. In elephant camps it is not unusual for a wild bull to arrive at the camp when a tame cow gets into season, and frequently the first act of the intruding bull, even before he seeks the cow, is to attack other adult tame bulls in the camp. In the Kargudi elephant camp of the Mudumalai Sa., two adult tuskers personally known to me (Caesar and Addi) were grievously wounded by wild bulls attracted to the camp by a cow coming into season. As in most other mammals, the condition of the cow is advertised by scent, but the elephant is unique in that a cow in season actively advertises her condition. Visually flagrant signs of her being in season are not manifested (even the mahouts know that their charges have come into season mainly by circumstantial evidence, such as the interest manifested in the cow by the bulls), but the cow bends her tail between her hind legs sharply so as to slap the abdomen with its tip, and then draws the brush at the tip firmly up, rubbing it against the vagina : the tail is then held aloft in the air and waved about, in a scent-flag (TN 64 Mar. 25).

While it is true that in most animals the male cannot mate unless the female is co-operative, the peculiar anatomy of the elephant and its courtship habits makes it absolutely necessary for the bull to have the co-operation of the cow for successful coition. Because the pre-copulatory play is gentle in the elephant, the bull cannot, by aggression or force, compel the co-operation of the cow—a situation that may arise in some other animals where there is little courtship prior to the sexual act. During this phase of courtship, the bull caresses the cow with his trunk and there are repeated gentle bodily contacts. While the bull elephant is not specially peculiar in his genital anatomy, except that the testes are not discrete in a scrotum but located within the body (a feature shared by some other animals, such as the whales and dolphins, shrews and sloths), the cow elephant has the widest perineum known among the mammals, and her vagina is situated low down, a vertical slit at the end of the abdomen ; this renders it quite necessary for the cow and the bull to be precisely aligned before copulation can be effected ; the bull lays his trunk along the cow's back from behind and manoeuvres her into position before attempting to mount her, a move dependent entirely on the willingness of the cow. During the brief period of copulation the animals move around in a quarter circle—this was noticed in two matings between wild elephants observed from far off and also in the mating between the camp elephant Suguna and a wild tusker observed and photographed from near (TN 64 Mar. 30).

The rule is one calf at a birth, but occasionally two are born. The camp elephant Tara, stationed at the Kargudi camp of the Mudumalai Sa., had twins some years ago from a mating with a wild tusker. In a gregarious animal that is unusually exclusive in its intraspecific associations, the relationship between the adults in a herd and the infants and juveniles assumes a special importance. G. P. Sanderson provides a succinct and excellent account of the extraordinary consideration for the young animals in a herd shown by the adults, but on one point he seems mistaken. He concludes that cow elephants display no special solicitude or attachment to their calves, permitting men to handle their newborn young, and that from what he has noticed during the capture of elephants in stockades, the young calves of a cow are often violently repulsed by the other cows in the herd. Tamed elephants, used to having their needs, and directions, provided by men, might not show any apprehension at their infants being touched by men: my experience is that the most dangerous and aggressive of all elephants is the mother elephant (or even the ' aunt ') apprehensive for the welfare of her calf; a remarkable instance of this was provided by two small cows, with a calf about a year or two old (the calf of one of them) between them, which came baldheaded for the riding elephant (a tusker much bigger than them) on which I was seated along with another companion and the mahout, because the tusker had been moved inadvertently close to the calf (TN 64 Sep. 18—photograph TN 38). While it is true that cows in a herd do repulse the calves of other cows on occasion (K 70 Apr. 21), it is patently incorrect to assume that the behaviour of any animal when it is confused, and panic-stricken and cannot escape, is its normal behaviour: as several observers have pointed out (especially Williams, to whom we owe the word ' aunt ') not only are cow elephants very patient with their own calves, but quite often they develop an attachment and a protective feeling towards the calves of other cows to whom they are specially attached. The camp elephant Rati at the Mudumalai Sanctuary, is known for her attachment to all young calves born in the camp. Occasionally both the mother of a calf or another cow may kick or push the youngster when it is being recalcitrant (K 70 April 21) but this is always intentional, and by and large in few animals are the young in a gregarious association treated so gently and solicitously as in elephants.

It is well-known that in a herd certain adult cows develop a deep attachment (which can only be termed ' friendship ') to certain other cows. Bulls, too, keep together when foraging apart from the herd, and it is a common sight to observe two or three ' lone bulls ' together. This attachment of one cow to another has been observed both in the wild and among tame elephants. Indeed, so well is this recognised that in elephant camps they are not separated from each other even when put to work (as when used for timber logging) not out of any sentimental motives but because otherwise the work suffers. During the period of the survey it was noticed that the camp elephant Rati (a fine upstanding cow in her prime) could not be used as a riding elephant at the Mudumalai Sanctuary, unless the aged Sundari was also taken along with her. Among wild elephants, the tendency of certain members of the herd to group together when the herd splits into parties for foraging may be noticed (TN 66 Apr. 21).

Some of the vocalisations of elephants are well-known, such as trumpeting, squealing, squeaking (the two terms are used to distinguish a louder sound of protest from a weaker and softer sound, usually of pleasure in elephants), roaring (usually indulged in by juvenile elephants of from one to 5 years, when separated from their mothers in the course of foraging), and a sudden metallic and at the same time tympanic sound made by rapping the trunk sharply against the ground (the sound seems to be produced mainly by the sudden percussion of the column of air in the trunk as it is expelled) which is a sound of apprehension and interrogation—strictly speaking, not all of these sounds are vocalisations, since some are produced not in the throat but in the trunk. Other vocalisations are less well-known and may be briefly set out here. One of these is a plaintive, reiterated 'kook-kook-kook', sounded when the animal suddenly discovers something that annoys it (such as the near presence of a man—TN 66 Apr. 9): it is a sound of protest, but I have also heard it used by an exceptionally burly tusker that was demonstrating at us and covering the retreat of the herd (which we were following) evidently as some form of communication to the herd. Very young calves (under 2 months) come out with a loud, quickly-repeated bark that is very like the barking of a dog (though louder and flatter), a sound that is known to very few mahouts, for it is not uttered by calves in elephant camps: it can be heard only from the calves of wild elephants, and seems to be an expression of exhilaration (TN 66 Apr. 22, 69 Sep. 23, 70 Sep. 29, Oct. 5). Older calves do not indulge in the vocalisation.

A loud, repeated smacking, made with the lips, is commonly employed by the leading adult animals in a herd when the herd is on the move and somewhat uneasy over what lies ahead (TN 69 Oct. 5): an adult cow smelling at the rump of another adult cow was also heard coming out with this smacking sound (K 70 May 4). Frequently, when the herd is grazing in the open (never in cover), the adults converge in a close circle, with their heads facing the centre, and seem to confer together; after such a conference, the animals usually move away steadily in one direction, keeping close together and not in a loose formation as when grazing (K 70 Apr. 20): I have never been able to get sufficiently close to elephants in 'conference' to know whether or not they make any sounds then, but believe they do come out with some soft, low sounds—they certainly do indulge in tactile expressions with their trunks then. Among tame elephants, two cows may be seen standing close together, almost in a huddle, caressing each other with their trunks and coming out with throaty, hardly-audible sounds—this is especially noticeable when two cows that are attached to each other meet after a separation.

Elephants in a herd are sometimes quite noisy, and at such times they are apt to be belligerent, and specially aggressive towards human intruders (TN 63 Sep. 19 and 20). The many vocalisations of a herd are often missed when observing elephants by day (partly, no doubt, because one is then preoccupied with seeing what one can), but in the stillness of the night and when conditions are specially favourable for hearing the sounds made, as when the elephants are grouped around a sheet of water (which acts as a most efficient sounding-board), grunts, grumblings, squeals, squeaks, trumpetings, 'kook-kook-kooks' and softer and less definable sounds may all be heard (K 70 Apr. 23). A sound which elephants frequently utter when they are alone (maybe in a herd the sound is drowned by the other sounds made by the animals) is a deep, audible sigh, made by the expulsion of air through the trunk—it is the one sound made by an elephant which is otherwise keeping utterly silent, and a sound for which men in elephant jungles must always listen.

Many observers have recorded becoming aware of the presence of wild elephants by hearing their intestinal rumblings—this, of course, is purely involuntary and no sort of vocalisation, even stretching the term to its widest application. But on occasion, an elephant, while standing still, will come out with a vibrant rumbling sound, low-pitched but clearly audible from some distance, that is a sound made in the throat, though the flanks also appear to vibrate while it is made. It is a sound difficult to describe, something between a low growl and a throbbing purr. A charging elephant may come on in silence (TN 69 Sep. 20) or utter a piercing, malevolent scream (TN 64 Mar. 30).

As in other mammals, intraspecific communications and expressions of mood and intent are not limited to vocalisations. The attitude of an elephant, the way it stands and moves, and the way it holds its head, tail, ears and trunk are all expressive of its emotional state. An elephant in a rage stands very still, without swinging its trunk or flapping its ears—the ears are held flat against the neck (K 59 May 20). When the animal is at peace with the world, the trunk is swung freely and the ears are flapped from time to time ; when the head is held high and movements are brisk, it is in high spirits. When undecided or perplexed, the tip of the trunk is sometimes inserted into the mouth or, in a tusker, the trunk is draped over the tusks and hangs from them. It is curious that both these ways of disposing of the trunk are repeated in sleep. K. Krishnamoorthy once observed a proscribed rogue (which he shot later) asleep on its side, with the tip of its curled up trunk reposing safely in the mouth, and in a big tusker observed by me sleeping standing, the trunk was draped over the tusks (K 70 May 6). Instinctively, elephants take good care of their trunk (a vitally important organ to them) both in repose and in action. When alarmed and on the point of bolting, the tail is thrown up and the head raised, with the ears fanned out and then folded back, an attitude that serves effectively in visual communication of the alarm to the other elephants around (photograph K 27).

The elephant's vision is said to be poor, but it seems to be much better than reputed. It is true that the animal is not good at picking out stationary human beings inconspicuously clad in dark colours—but for this, I would not be writing this report. As against this inability (an elephant's inability to see what is right beneath it, such as a man crouching in a bush, is no doubt partly due to the bulge of its cheeks and the base of its trunk), the fact that a great many intraspecific signals are usually sensed visually must be offset. An old cow returned to the water at which a younger cow was lingering after the rest of the party had left after drinking, stood on the bank for a moment and then moved off, when the younger animal instantly followed (TN 70 Sep. 24): I have observed this mode of beckoning to a member of the herd that lags behind on a few previous occasions as well. An elephant in cover wishing to cross an open space to get to other cover beyond inspected the open ground visually and also investigated it by smelling, before crossing it (TN 66 Apr. 9). At times, when it has been apprised by smell of the near presence of a man, an elephant turns round for visual confirmation of its olfactory perception (TN 63 Sep. 19: MISC 68 Feb. 19—photograph MISC 4).

The sense of smell, of course, is paramount. Even apprehension of fodder specially fancied seems to be by smell—a near-blind riding elephant was still able to know that a tree, the foliage of which she liked, was some 15 feet to one side of the path she was following, and to alter her course to eat the foliage. The presence of men near-by is often revealed to an elephant by smell, when it instantly pinpoints the smell with the tip of its trunk—it also looks hard in that direction (MY 69 Oct. 16; K 70 May 1 and 10; TN 70 Sep. 28—photographs K 22, K 43). On two occasions, when I provoked a tusker to charge me, the animals instantly charged the moment I gave them my location definitely by walking into the wind (TN 63 Mar. 30 and 69 Sep. 20). Even the reverse of the seeking of visual confirmation of the proximity of men perceived initially through smell was observed, i.e., olfactory confirmation sought by the trunk being pointed in the direction of the men seen, when the animal could not possibly smell them, the wind blowing from it to the men (K 60 Apr. 16: MISC 65 Oct. 22; TN 70

Sep. 27—photograph MISC 2). When an airborne scent is above the level of the elephant's head, the trunk is raised high to investigate it.

Elephants are well able to follow ground-scents, like blood-hounds. A cow followed me entirely by ground-scent, with a strong wind blowing from her to me (TN 63 Sep. 19—photograph TN 28) and on two occasions wild tuskers followed the tracks of the tame elephant I was riding by ground-scent (TN 64 Apr. 10 ; MY 68 Oct. 21—photograph MY 10): another wild tusker was observed sedulously following a ground-scent, probably the track of a wild elephant (TN 66 Apr. 21).

G. P. Sanderson says that when there is an alarm, the big bull of a herd runs away on his own and does not cover the retreat of the herd. This is generally true, but on occasion the bull does cover the retreat of the herd. Once, when I was following a herd along with some trackers, we were halted by a singularly burly and powerful tusker which stayed behind while the rest of the herd moved into thick tree cover, and staged a most impressive demonstration, pushing over a stout sapling and then kicking it between his legs : later, when we had been halted, he moved off in the wake of the herd. Frequently such demonstrations to intimidate and halt men take the form of pushing over trees or goring small clumps of bamboos or bushes (TN 64 Mon. 25—photograph TN 33). A cow may demonstrate at a man following her by turning round and rushing towards the intruder in a short, formal charge (K 70 Apr. 22 and 29). Sometimes an elephant, resenting the presence of a man, may graze gradually towards him at a tangent, and then turn in sharply for a charge when near enough (photograph K 30).

The elephant is one of the few mammals that, even when adult, indulges in play. When bathing in company in a forest pool, it is not only the juveniles that revel in play : even the adults bump into, push down, and roll over one another with abandon—perhaps they find the sudden lifting of their ponderous weight off their feet by the water exhilarating (K 60 Apr. 11 and 17 ; MY 68 Oct. 26 ; TN 70 Sep. 29—photographs MY 16 and 19, TN 62). On land, too, adult bulls may indulge in a long bout of play with their trunks, not in a tug-of-war so much as a pushing match, or in chasing each other (TN 63 Mar. 24, 69 Sep. 23 and 24 ; 68 Oct. 11—photographs TN 52 and MY 7).

It is not unusual to find two, or sometimes three, ' lone bulls ' going about in close company—no doubt these are bulls from a herd staying, for the time being (which may be for 3 or 4 weeks, or a lesser period) away from the herd. In such associations the younger or smaller bull often displays a noticeably subordinate position to the big bull, and is termed his ' chela '. The most expressively overt act of such subordination is the offering of a choice twig or a sheaf of foliage, by the chela to the big bull (TN 66 Sep. 17).

Sanderson records seeing a young male calf all by itself. A 5-year-old bull calf was also seen by me, contentedly feeding by himself throughout a day—there were no other elephants around (TN 59 Apr. 1). Such solitary animals are most exceptional, and one never sees an adult cow by herself, though a cow and her grown calf were repeatedly seen grazing by themselves on a hillside, not joining the other elephants on that hill (K 70 Apr. 19, 21, May 4, 5). Only adult bulls are normally seen by themselves.

These, as Sanderson points out, are seldom 'lone bulls', but the big bulls of some herd which may be, for the time being, staying away from the herd. He doubts if there is any such thing as a true 'lone bull' and dismisses the theory of an adult bull being driven away from the herd by a stronger bull as fancy. He is largely correct in much that he says, but while it is true that few bulls, if any, are truely solitary, there are records of bulls having been seen for years on end staying by themselves, or sometimes in close association with another bull: since such animals do not wander far as elephants in herd do in their seasonal quest of food, their movements are well known to the forest-living people of the area. The question is really not one so much of fact as of terminology. If, by the term 'lone bull' is meant an animal that never, in no circumstance whatever, associates with others of its kind, Sanderson is correct and there are no 'lone bulls'. The loneliest of them will, on occasion, seek the company of a cow in season or even associate with another bull for a brief while. However, if the term 'lone bull' is applied, much more properly, to an adult male that is solitary as a rule and does not join a herd except in a transient association, there *are* lone bulls among elephants. The tusker that killed the camp elephant Shibji in the Jaldapara Sanctuary (MISC 65 Oct. 20—photograph MISC 2) was known to have been solitary for years; similarly, the bull proscribed in the Mudumalai Sanctuary as a rogue (TN 59 Mar. 6 and 21) was long known as a solitary elephant in the sanctuary, though on occasion he was accompanied by a small mukna (TN 59 Mar. 6). A big tusker with magnificent tusks and peculiarities of build that proclaimed his identity was well known as a true lone bull in the Periyar Sanctuary for over a decade, and was never seen in the company of other elephants, though elephants are seasonally common in the area (K 59 May 20, 60 Apr. 4, 70 Apr. 19—photograph K 2). Other instances of a bull living by itself for years are known. Forest-living tribals and elephant men know the distinction between such truly solitary bulls and the bulls of herds that occasionally leave the herd to be alone for some time—they call the former 'lone bull' and the latter 'the lone bull of the herd', a contradiction in terms rendered necessary by the confusing social habits of elephants! In the field notes the term 'lone bull' has been used loosely to mean both kinds of solitary bulls, but the context will make it clear which kind was meant. True lone bulls may, on occasion, drink with a herd or stay close by a herd, or even mate with a female in a herd or in an elephant camp. Such a lone bull was seen near a herd (which included three adult tuskers) at a river, but when the animals left after drinking, the herd and the lone bull went their separate ways (TN 70 Sep. 28).

G. P. Sanderson's argument that a true lone bull is never an animal driven out of a herd but one that has chosen a solitary life of its own accord, while generally true, is not invariably so. K. Krishnamoorthy once saw, first the big tusker of a herd and later the entire herd, chasing a lone bull that had attempted to enter a herd over a long distance. A solitary bull cannot just walk into a herd and be accepted, even if he is prepared to accord priority to a larger bull already in the herd, as a matter of course. Elephants are exclusive in their intra-specific gregariousness, and may not accept a newcomer : they may ; the truth is we do not at present know what prompts them to react differently on different occasions in this regard. Even among animals moving in a herd, there may be sharp antagonism between adult bulls. There was only one herd of elephants in the Palamau National Park in February 1969, in which there were two muknas, both in musth : the older and larger of the two muknas actively resented the presence of the smaller, and chased him away (B 69 Feb. 23—photograph B 16).

Fights between adult bulls may be to the death, though much more commonly they are only skirmishes. Usually such major fights are between solitary bulls (whether or not one or both of them are true lone bulls), and may be sustained over a period of days, with breaks for feeding and drinking. Obviously sexual rivalry is not the cause of action (to borrow a convenient legal term) and the fight is not for the favours of a cow—such fights, too, are known, as already reported. It is not always that two bulls in the same area engage in such combats : even where a measure of hostility is apparent between the two, one may avoid the fight (TN 70 Sep. 29, Oct. 3). Considering the fact that elephants are much given to wandering over a wide area (though solitary bulls are less given to such wandering) and the further fact that several parties, herds and individuals usually feed in the same area without disputing the territory (vide the entire field notes for April-May, 1970, Periyar Sanctuary), such fights do not appear to be motivated by territorial rights—at times, though, they appear to be so motivated. Probably they are fights in assertion of dominance, when the paths of two big bulls happen to cross : human analogies are not far to seek.

All solitary male elephants, whether or not true lone bulls, are usually considered dangerous and miscalled 'rogues'. Some of them are belligerent towards men, some are not. It has often been said that of no wild animal are forest-living men so afraid as of the elephant, and this is quite understandable, because of the unpredictable response of chance met elephants in forests (MY 68 Oct· 15). However, few seem to realise that the aggression of elephants towards men in areas where men have invaded elephant country is almost invariably motivated by human hostility initially, or that the shooting of elephants is something that has to be done expertly, if it has to be done at all, and that the wounding of the animals may only lead to further trouble. Almost invariably a proscribed rogue (i.e., an animal that has killed a man or a few men, and which has therefore been proclaimed a rogue) carries gunshot wounds, probably received in the course of raiding a sugarcane plantation or other crops, which have suddenly sprung up in what used to be primeval forest. For some reason, gunshot wounds do not heal easily in elephants, though other animals recover from them. They are apt to form festering sores, usually maggot-ridden, that cause considerable pain and handicap the animal, and they persist even for years. The proscribed rogue I observed in the Mudumalai Sanctuary in March 1959 (TN 59 Mar. 21) still carried unhealed bullet wounds when he was shot by E. R. C. Davidar some 2 years later.

The impact on elephants of human invasions of their territory is of special interest and significance. Most other diurnal animals retreat from their homes before human invasions of the deep forests, or else turn into fugitive creatures of the night, hiding by day in cover because men are active in the forests then. The elephant is not entirely, or even almost entirely, diurnal in its activity, but it seems to be the only wild animal with a sufficient sense of territory (in the face of extra-specific intrusions into its old homes) and a sufficient resentment of being disturbed and harried by men, to turn consequentially hostile towards men. In forests where they are little disturbed, the normal reaction of elephants to near human presence is flight. A big herd I was following at a distance, with the wind blowing from the animals to me, turned round suddenly and came towards me (and the cover of tree forests) at their fastest pace, running helter-skelter over uneven open ground : a while later, what had alarmed them (by scent) came into view, a small boy of about 8 herding a buffalo cow. A tusker about to emerge from thorn bush turned back and retreated into the dense cover on hearing the sound of a man cutting wood with an axe (TN 64 Mar. 21). Many instances of the natural tendency of wild elephants to bolt from the near presence of men are on record. They are even able to associate cattle with men, and usually flee from cattle, unless they are sure that there are no herdsmen with the beasts (TN 64 Mar. 21, 69 Sep. 23).

Where they have been much disturbed and harried by men, their reactions to humanity undergo a change. Flight is still the commonest reaction, but they may become more assertive and indulge in demonstrations and even in attacks. An interesting response, when elephants have to cross a road in a forest and stay close to the road to drink or feed, is to pull down a few culms of giant bamboo from a roadside clump, or a sapling, across the path and constitute a road-block (TN 66 Oct. 6 ; MY 68 Oct. 9).

In assessing these responses and aggressiveness to men, it should be remembered that elephants are longlived animals with a clear topographical comprehension of their stamping grounds and that their resentment of intrusions, such as man-made structures, into their territory, and their proclivity to destroy such structures is something that can even be anticipated (TN 59 Mar. 31). It is said that on occasion their hostility to men takes the form of flinging stones (by the trunk) at the intruders, a less wildly improbable response than it might seem to those not intimately familiar with elephants. Tame elephants sometimes demonstrate their dislike of being annoyed by picking up and throwing a stone at a man—this is something well known, and it is even common knowledge among men in elephant camps that some tame elephants are more prone to this action than others. I have personally experienced the resentment of my attempt to get close to a herd (in which there were young calves) by the leading cow of the herd getting on to a path above me and sweeping down stones and debris at me from above with her trunk (K 70 May 2—photograph K 26).

The more usual manifestation of resentment of human intrusion is a demonstration or a charge (TN 63 Sep. 19 and 20, 64 Mar. 25, 69 Sep. 20, 70 Sep. 19). However, even in an area like the Moyar block of the Mudumalai Sanctuary where what was long known as a favourite haunt of wild elephants has been invaded by a hydro-electric project, canals, clearings for the powerlines, human settlements, and agriculture and plantations, and where the human population has increased enormously and thousands of cattle are herded everyday in the forests, what is positively astonishing is not the occasional aggression of the wild elephants but their acceptance of man-made intrusions and their tolerance of humanity (photograph TN 29). Almost every year a few people are killed by elephants in and around the Mudumalai Sanctuary (the entire area, as explained in the General Account of the sanctuary in the notes for 1959, must be taken as one natural wildlife unit, though politically demarcated between three States) but these killings occur in the course of chance encounters between men and elephants inside the forests, and not at human settlements invaded by the elephants: incidentally, cows and even subadults are responsible for many of these attacks and not only the adult bulls, and as many attacks are caused by panic as by deliberate hostility.

A consequence of the invasion of elephant forests by men is that with their territory much reduced in extent and with constant disturbance from humanity, small herds moving into the area leave it in a panic (especially when seasonal conditions are unfavourable to them) and move near surrounding human settlements. Further, the raising of crops in the immediate vicinity of forests leads to crop-raiding by elephants. The methods at present in use against such crop-raiding elephants are mainly the firing of crackers to scare them off, the digging of elephant-proof ditches around the fields (a laborious and costly method), and, of course, the use of firearms, usually inexpertly and from too far away, usually resulting in the elephants turning hostile to the men. Since elephants are most vulnerable on their perception-frontier of smell, it would be in the interests of wildlife protection in India as well as of agriculture if some liquid which is not volatile and which could be sprayed in a 20-foot wide belt, with a smell unacceptable to elephants, could be discovered or synthesised: such a scheme, naturally, involves experimental work by research chemists to ascertain which liquid would repel elephants (camp elephants) and at the same time not harm men or crops through accidental contact, but though I have repeatedly made the suggestion to those who might be able to act on it, the response to my suggestion, so far, has been entirely one of 'no-enthusiasm'.

An incidental consequence of the human occupation and invasion of elephant forests is the rumour, published from time to time in the popular press, to the effect that there is an alarming increase in the number of elephants and that this has been noticed by forest officials, who had seen calves with herds where formerly they had not seen any calves. Naturally, more elephants are seen with the deeper penetration of officials and others into the forests. As for the sudden sighting of calves, presumably there were calves even in the past, for there to be calves now, and no further comment is necessary beyond this passage from THIRTEEN YEARS AMONG THE WILD BEASTS OF INDIA by G. P. Sanderson: 'When an alarm occurs in a herd the young ones immediately vanish under their mothers, and are then seldom seen again. A herd containing a large number of calves would be supposed under these circumstances by the uninitiated to consist entirely of full-grown elephants.'

The composition of the herd has been reserved to the last intentionally. Prater says that the herd is, in the main, a family unit. This is to be construed liberally. A herd may consist of one or more families with an intermingling of unrelated individuals, and on occasion (while moving to fresh ground) two or more herds may unite into one large composite herd, marked by the presence of a number of big bulls in their prime (TN 59 Mar. 28, 66 Apr. 21, 22 and 23). In the course of daily foraging the herd (whether single or composite) usually splits into several parties which may feed at quite some distance from one another. However, normally there is no intermingling of two herds, or two parties belonging to different herds, even if they are close to each other or passing each other along the same path. I have observed this in many different areas, in the Periyar, Mudumalai, Bandipur and Kaziranga sanctuaries and in Corbett National Park. As already said, normally exclusiveness is a feature of elephantine herd associations. Very old animals as well as very young calves, and elephants of all intermediate ages, may be found in a herd. Where there are more than one adult bull in a single (not composite) herd, one may be very old and the other in his prime, or the lesser bull's acceptance of the dominance of the big bull may be evident: however, it is only rarely that two big bulls are found in a single herd: all records showing several bulls probably pertain to composite herds. The following excerpt from a description of a large herd (evidently composite) seen by Sir Victor Brooke in July 1863 in the Biligirirangan hills of Mysore is vivid, and except for its conjecture of the probable descent of many members of the herd from the patriarch, no doubt factually true: 'There were about eighty elephants in the herd. Towards the head of the procession was a noble bull, with a pair of tusks such as are rarely seen nowadays in India. Following him in direct line came a medley of elephants of lower degree—bulls, cows, and calves of every size, some of the latter frolicking with comic glee, and bundling in amongst the legs of their elders with the utmost confidence. It was truly a splendid sight, and I really believe that while it lasted neither Colonel Hamilton nor I entertained any feeling but that of intense admiration and wonder. At length the great stream was, we believed, over, and we were commencing to arrange our mode of attack, when that hove in sight which called forth an ejaculation of astonishment from each one of us. Striding thoughtfully along in the rear of the herd, many of the members of which were, doubtless, his children, and his children's children, came a mighty bull, the like of which neither my companion, after many years of jungle experience, nor the two natives who were with us, had ever seen before'. Nowadays it is seldom that one can see such a composite herd. That there were such huge herds even only 30 years ago is borne out by the testimony of those who have seen them when the elephant forests of the South were more extensive, and primeval.

THE GAUR

Bos gaurus (Smith)

(Summary of field notes : Observation records 166

Locations : Kerala—Periyar Sa.; Tamil Nadu—Mudumalai Sa.; Andhra Pradesh—Eturnagaram ; Orissa—Badrama ; Bihar—Tholkobad, Palamau N.P.; Madhya Pradesh—Kanha N.P.; Maharashtra—Taroba N.P.

Photographs : K 7, K 19, K 31, K 32, K 33, K 34 and K 42.
TN 1, TN 3, TN 4, TN 7, TN 10, TN 11, TN 13, TN 15, TN 16, TN 18, TN 19, TN 20, TN 22, TN 24, TN 30, TN 31, TN 32, TN 36, TN 39, TN 40, TN 47, TN 48 TN 49, and TN 63.
O 1 and O 2.
B 3, B 4, B 5, B 11, B 15, B 34 and B 37.
MP 3, MP 5, MP 15, MP 26, MP 34, MP 35, MP 37 and MP 38).

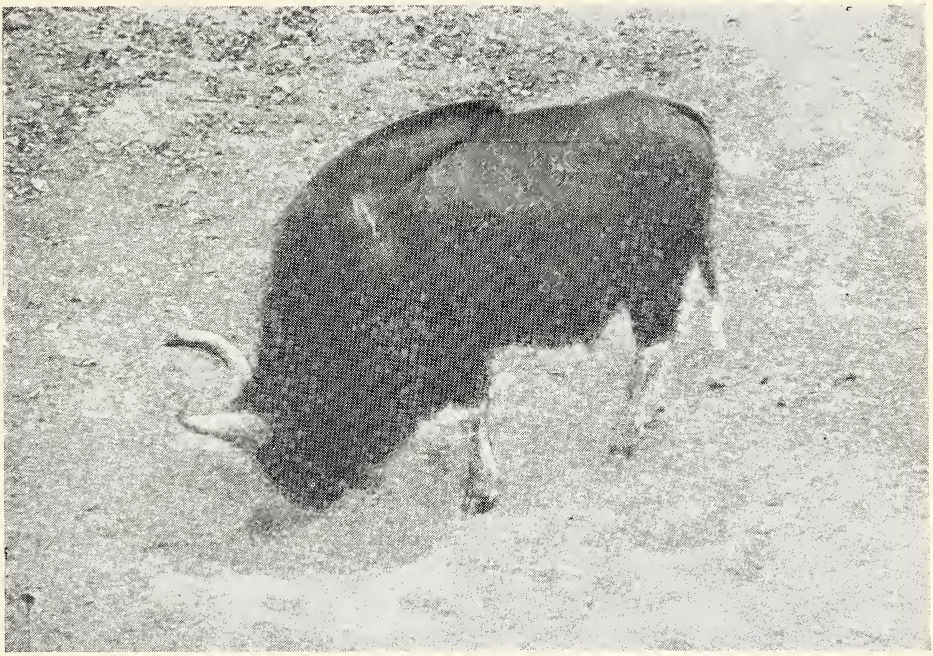
The gaur is the tallest of living oxen, and the second heaviest, the Indian wild buffalo being more massive though shorter, more powerful and much more belligerent. Gaur attain their best development within peninsular India in the lower slopes of the Western Ghats and connected hill ranges, and the literature available on this most magnificent wild ox does not suggest that elsewhere in its wide distribution over S. E. Asia it attains a superior size. Since my experience of gaur, with exceptional opportunities for close and prolonged observation, differs in some particulars from the accounts of others, some space has been devoted to this animal as well.

Size : Morphological characters

Before detailing the physical dimensions of gaur as fixed by the best authorities on the animal, it is necessary to make an important point regarding the size of large mammals in general, unappreciated so far in the literature on India's fauna. All measurements of almost all the larger mammals are only approximate, and this should be kept in mind.

In regard to one particular Indian mammal alone, the tiger (and by its generic affinity to it, the leopard), has there been searching inquiry into measurements and standardisation of the method of measurement. Because of wide differences in the length of a dead tiger as measured by different men, when the length from nose to tail-tip was taken along the curves, the system of measuring the length between pegs, which reduced human error in measurement (whether intentional or not) to negligible proportions, was insisted upon. It is significant that it is the tiger's length that is measured between pegs, for this is a dimension which is little affected by the animal being dead, it being unlikely that when alive the tiger could have stretched itself to an appreciably greater

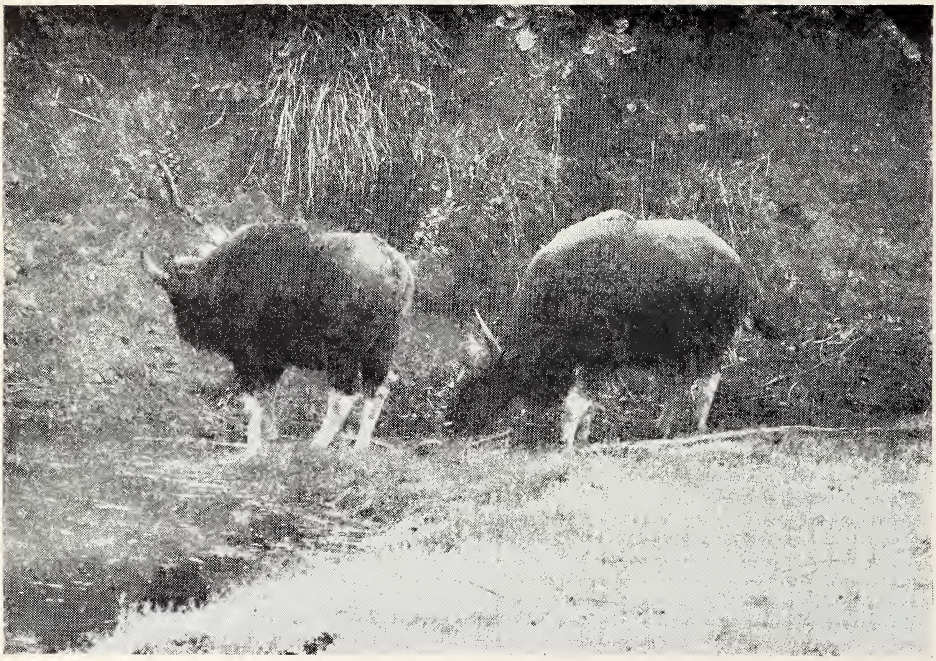
Krishnan : Mammals

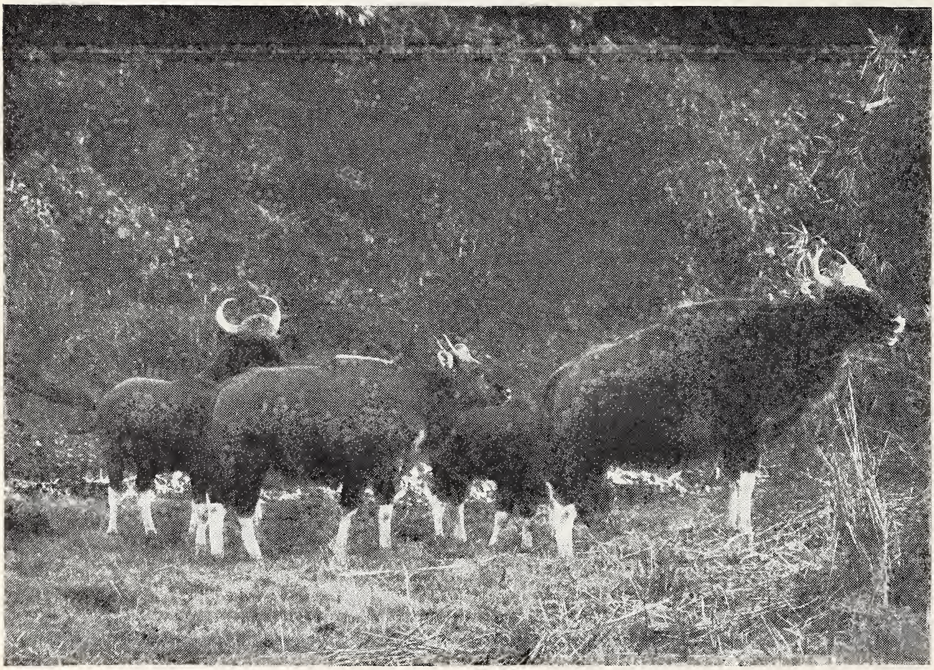


Above : bihar 1969 : tholkobad : Ligirda watch-tower : February 4 — 7 a.m. : The lone bull gaur with the ample dewlap — b. 5 ; *Below :* bihar 1969 : betla : palamau : February 21 — Night : Gaur cow — b. 15.

(*Photos : M. Krishnan*)

Krishnan : Mammals

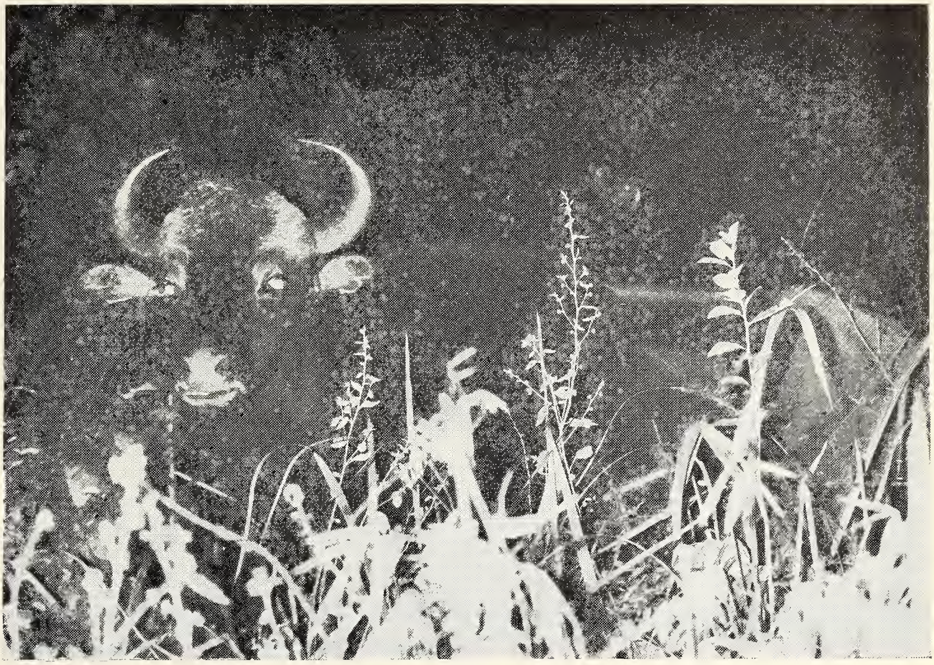


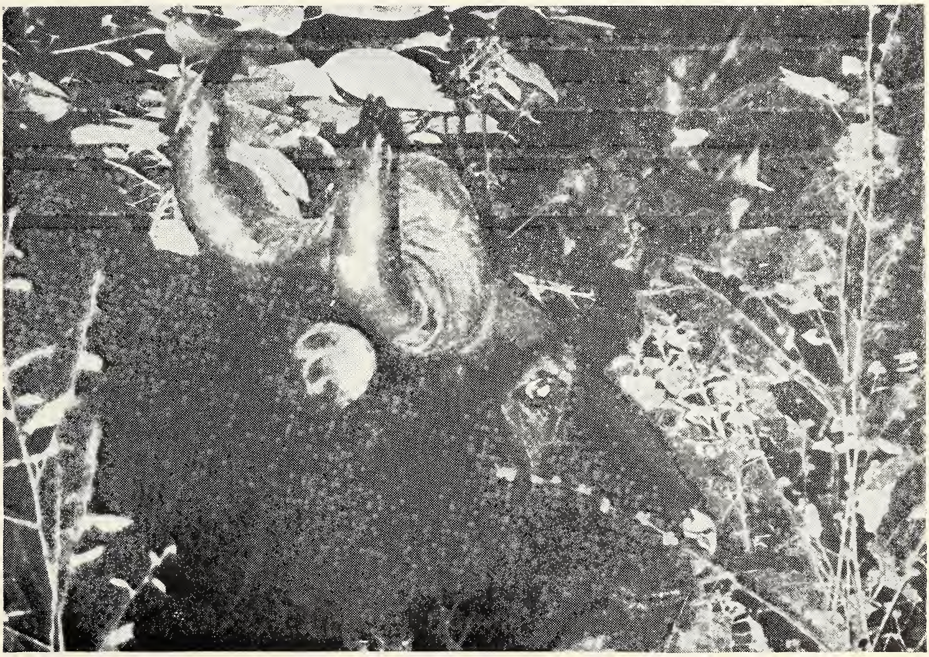


Above : BIHAR 1970 : BETLA : PALAMAU N. P. : February 24 — 8 a.m. : Gaur cows at Madhuchuan — B. 34 ; *Below* : BIHAR 1970 : BETLA : PALAMAU N. P. : March — 1 : about 5 p.m. : Gaur at Madhuchuan — B. 37.

(*Photos : M. Krishnan*)

Krishnan : Mammals

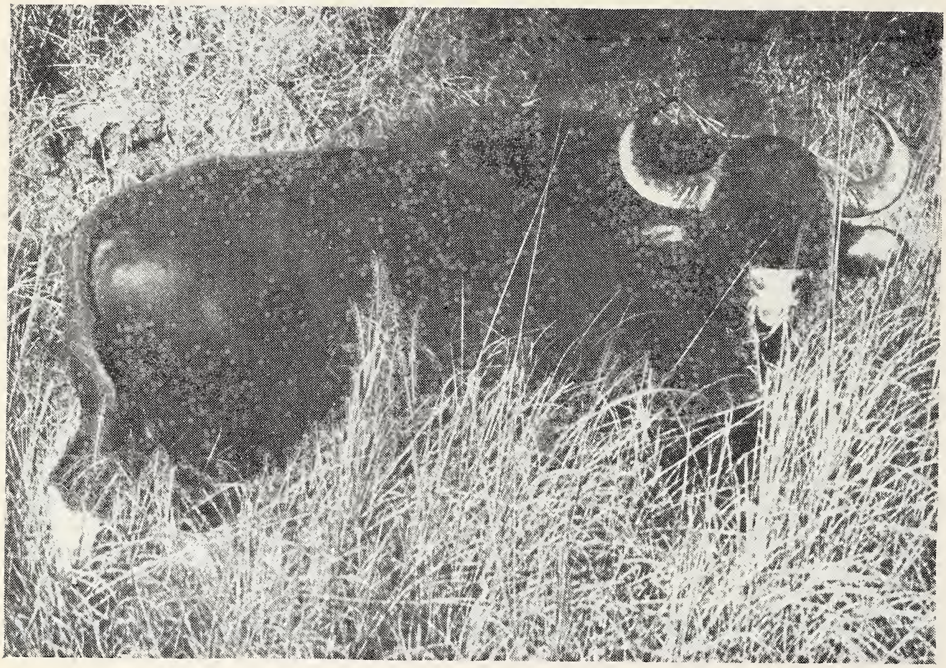


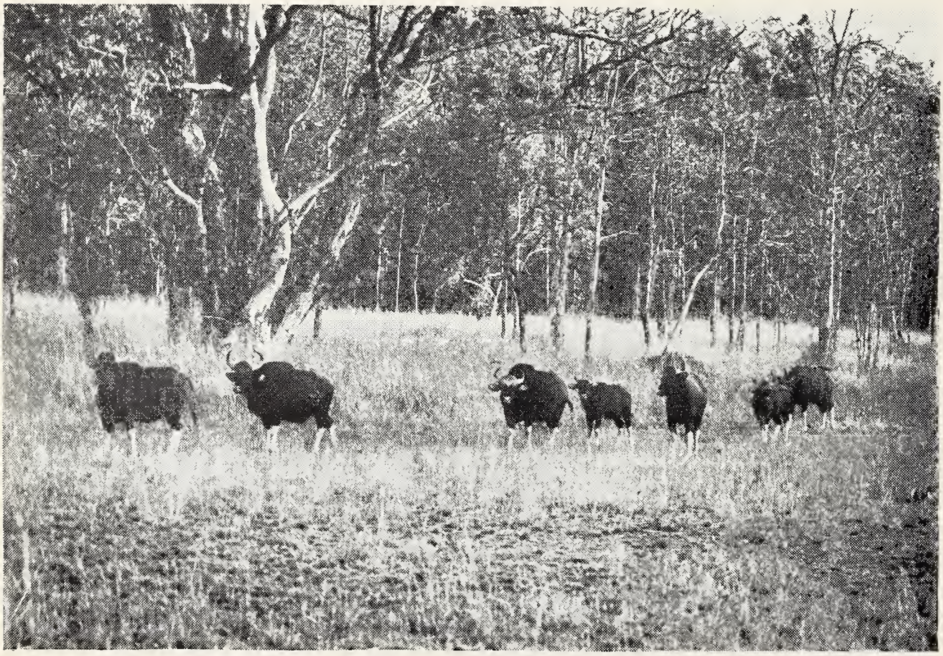


Above : orissa 1969 : usha kothi sa. : January 26 — night drive : Young gaur cow — o.1 ; *Below :* orissa 1969 : usha kothi sa. : January 27 — night drive : Gaur bull — o.2.

(*Photos : M. Krishnan*)

Krishnan : Mammals

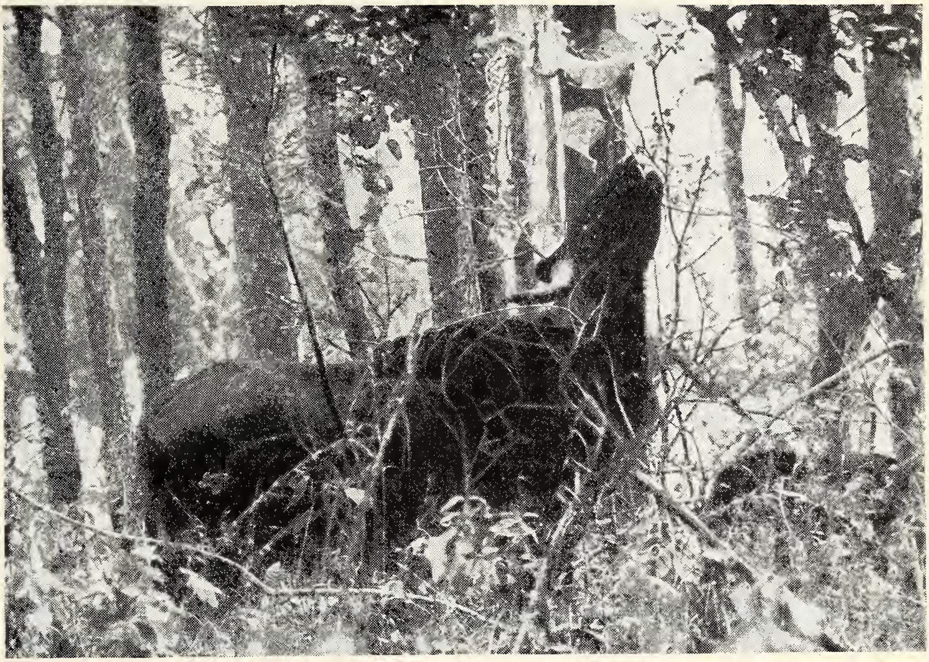


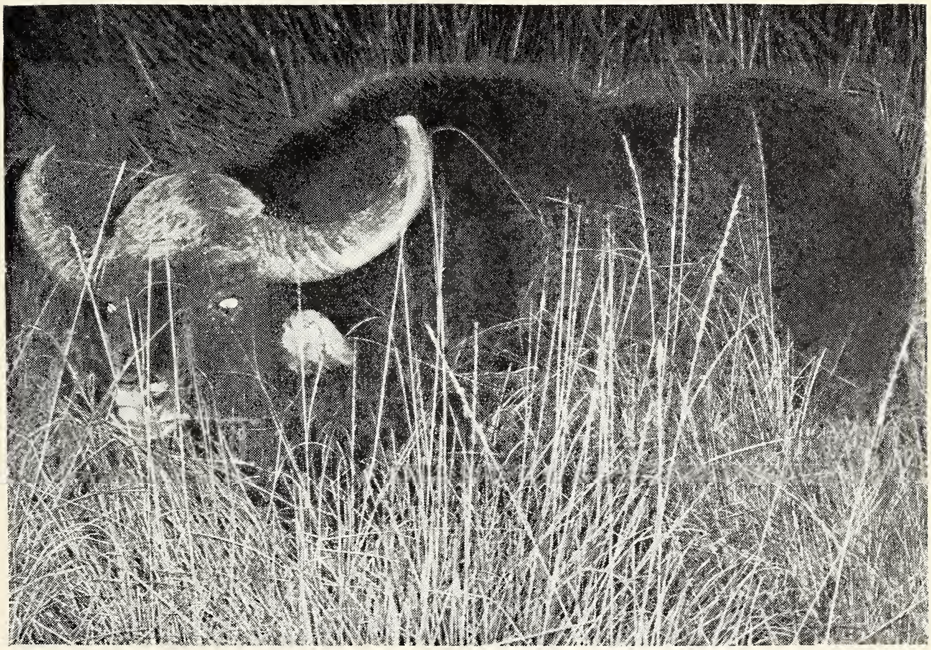


Above : M. P. 1968 : KANHA N. P. : May 4 — a.m. : Lone bull gaur — MP. 3 ; *Below :* M. P. 1968 : KANHA N. P. : May 4 — p.m. : Part of a herd of gaur — MP. 5.

(*Photos : M. Krishnan*)

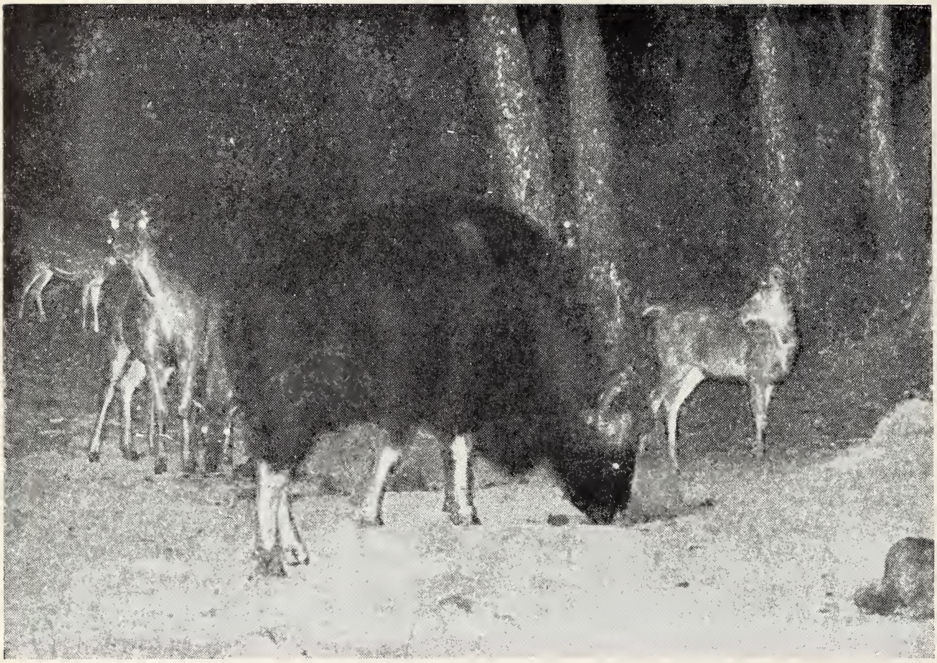
Krishnan : Mammals

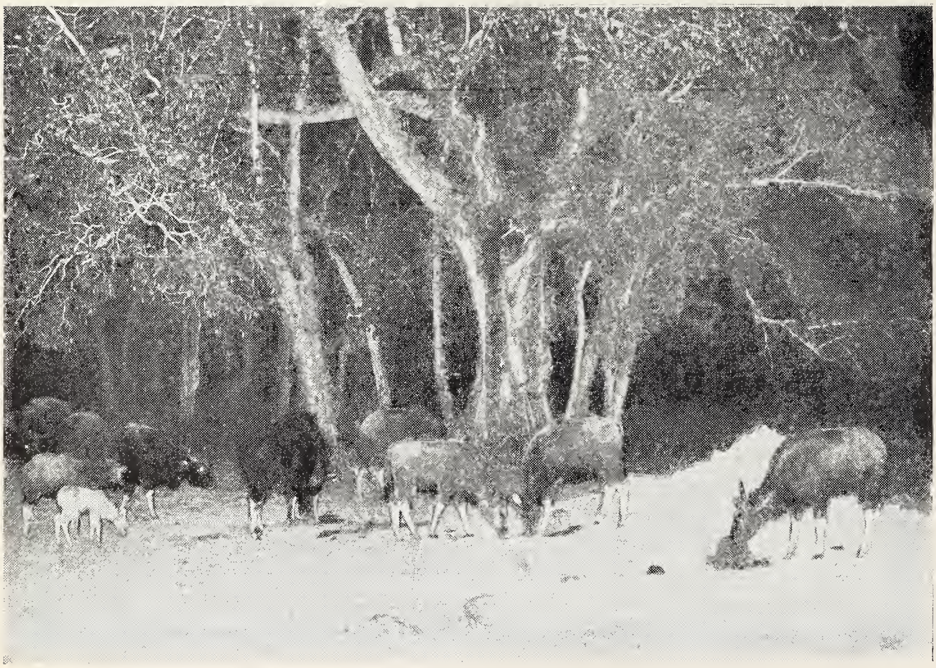




Above : M. P. 1969 : KANHA N. P. : March 8 — p.m. : Gaur cow eating *Smilax* — MP. 15 ; *Below :* M. P. 1970 : KANHA N. P. : March 5 : about 9 p.m. : Lone bull gaur grazing at a roadside ditch — MP. 26.

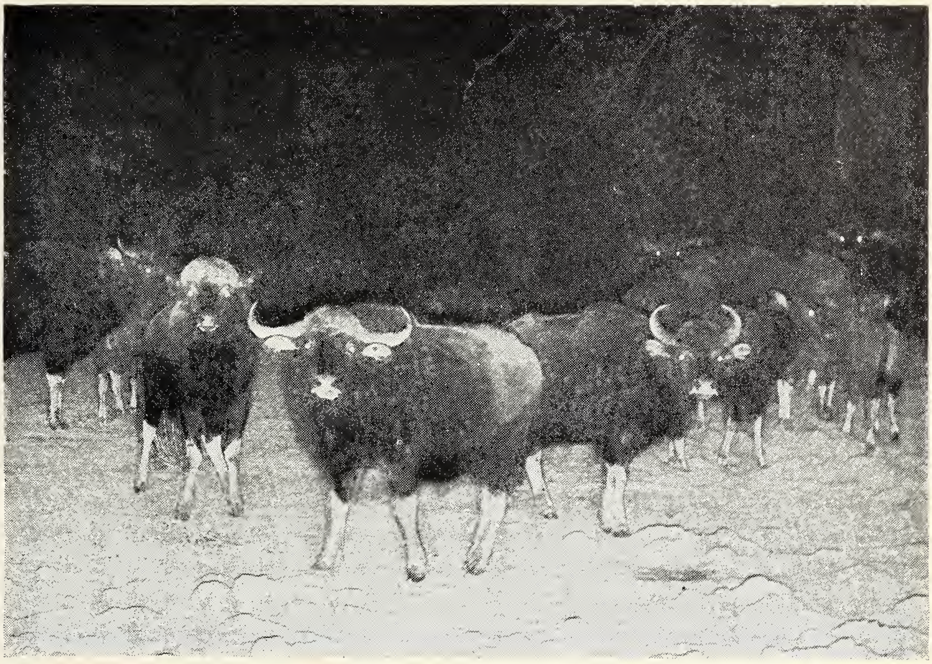
(*Photos : M. Krishnan*)

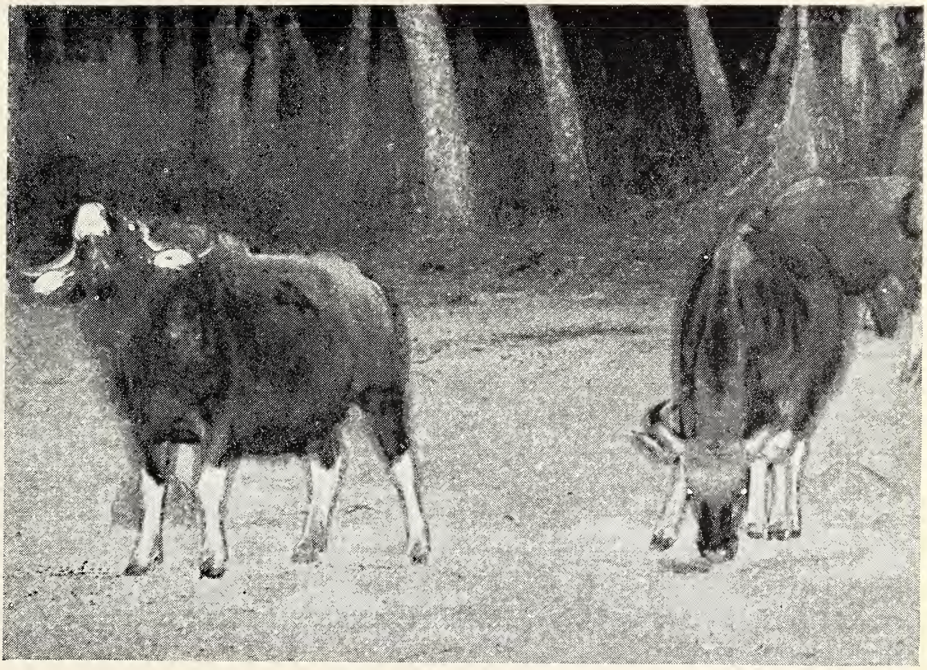




Above : M. P. 1970 : KANHA N. P. : March 17 — about 10.30 p.m. : Lone bull gaur, sambar hinds, and a chital at the lick — MP. 34 ; *Below :* M. P. 1970 : KANHA N. P. : March 17 — 11.40 p.m. : The herd of gaur at the lick — MP. 35.

(*Photos : M. Krishnan*)

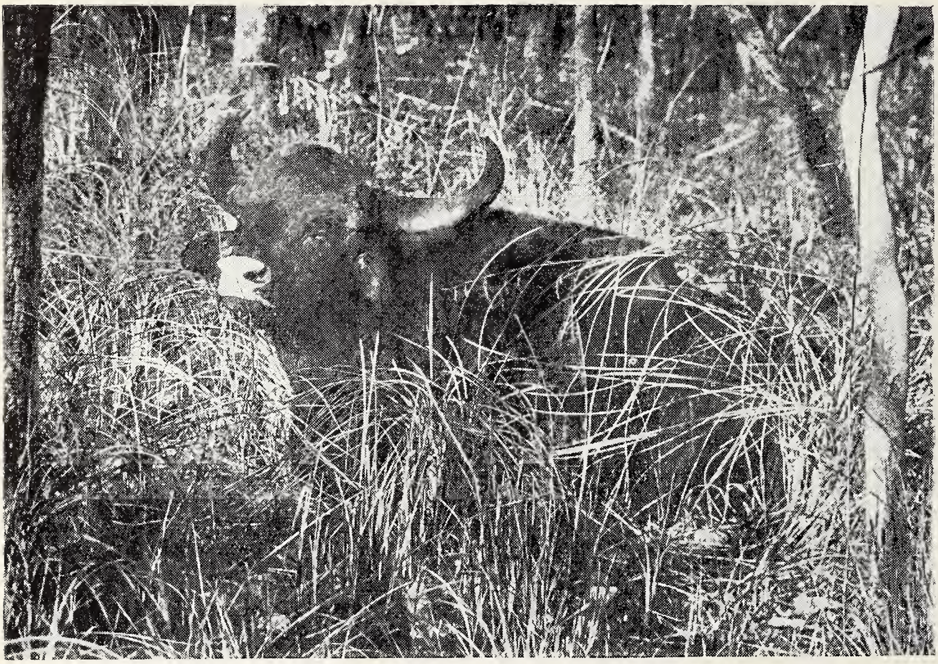


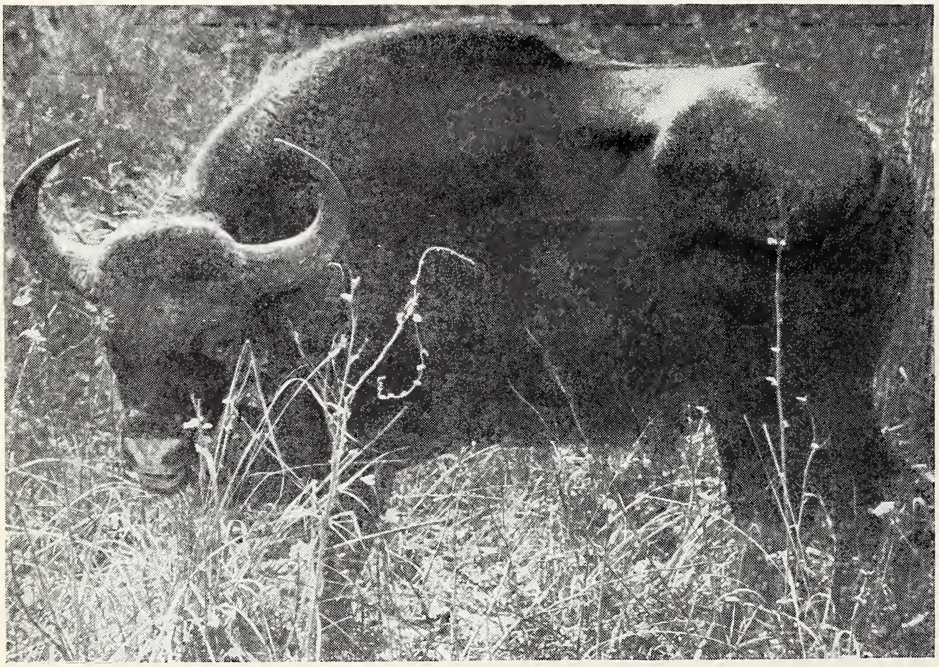


Above : M. P. 1970 : KANHA N. P. : March 20 — about 10.30 p.m. : Gaur at Sravantal lick. Note horizontal horns of the small bull in the foreground — MP. 37 ; *Below :* M. P. 1970 : KANHA N. P. : March 20 — about 10.40 p.m. : The bull shown in the previous picture calling — MP. 38.

(*Photos : M. Krishnan*)

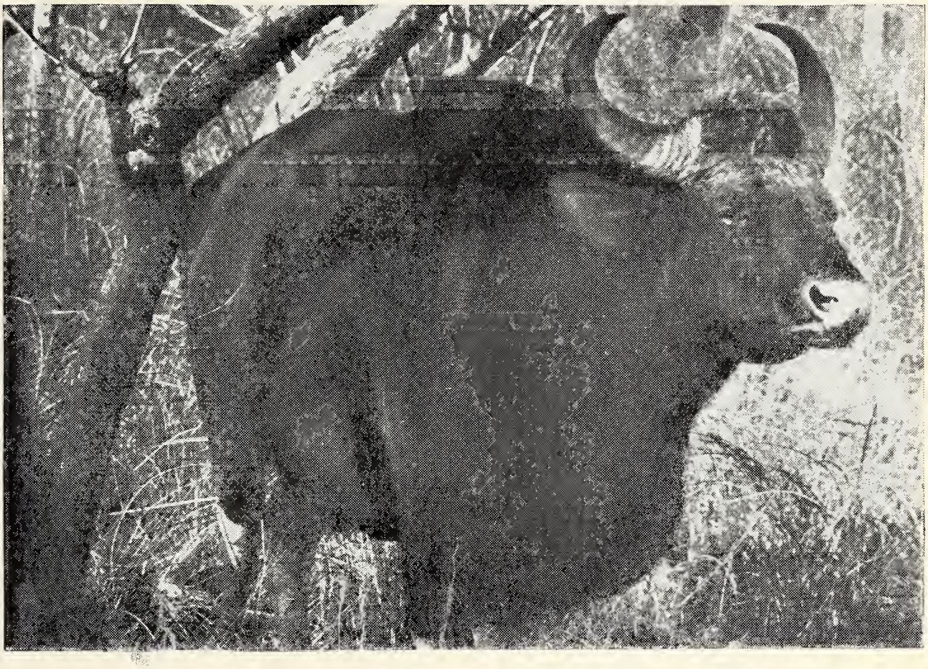
Krishnan : Mammals

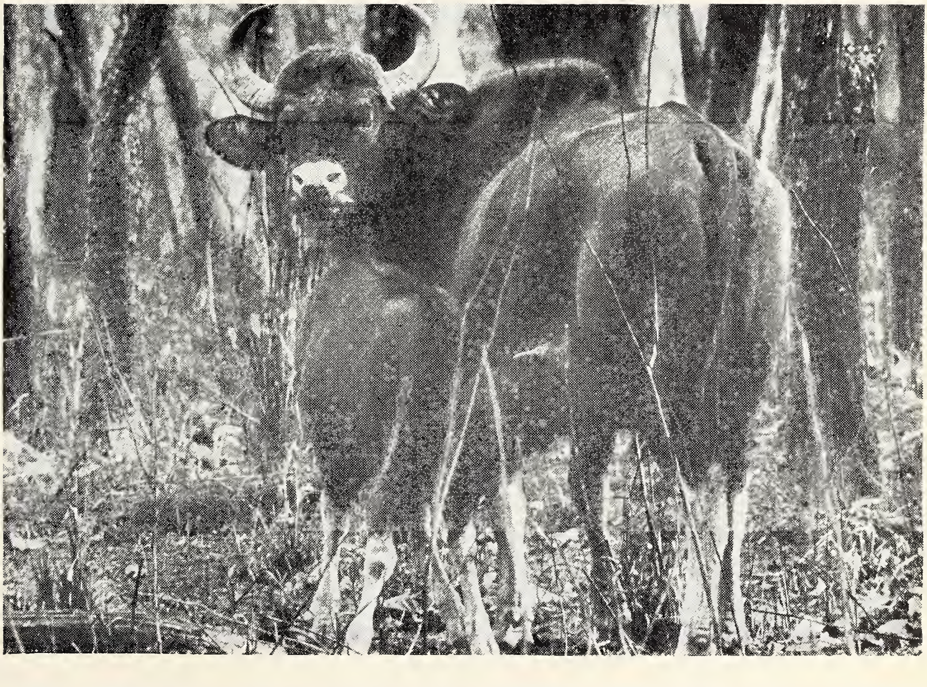




Above : TAMIL NADU 1959 : MUDUMALAI SA. : Kargudi : March 9 — p.m. : Lone bull gaur lying up in sparse grass — TN. 1; *Below :* TAMIL NADU 1959 : MUDUMALAI SA. : Kargudi : March 16 — a.m. : The lone bull gaur in c. 2 — TN. 3.

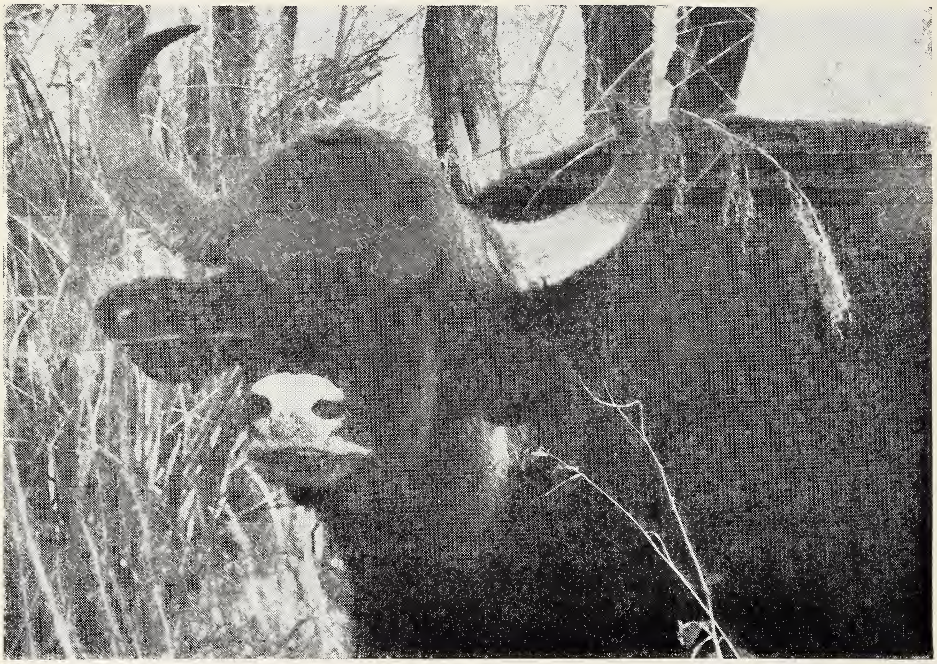
(*Photos : M. Krishnan*)

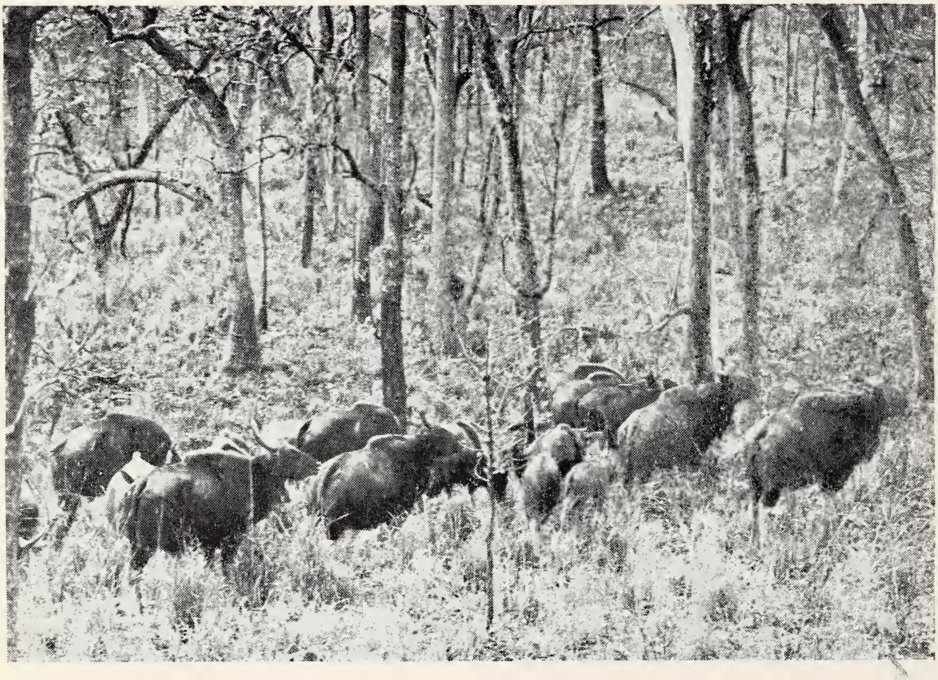




Above : TAMIL NADU 1959 : MUDUMALAI SA. : Kargudi : March 16 — p.m. : The herd-bull that covered the retreat of the herd — TN. 4 ; *Below :* TAMIL NADU 1959 : MUDUMALAI SA. : Kargudi : March 31 — p.m. : The big cow suckling her grown calf — TN. 7.

(*Photos : M. Krishnan*)

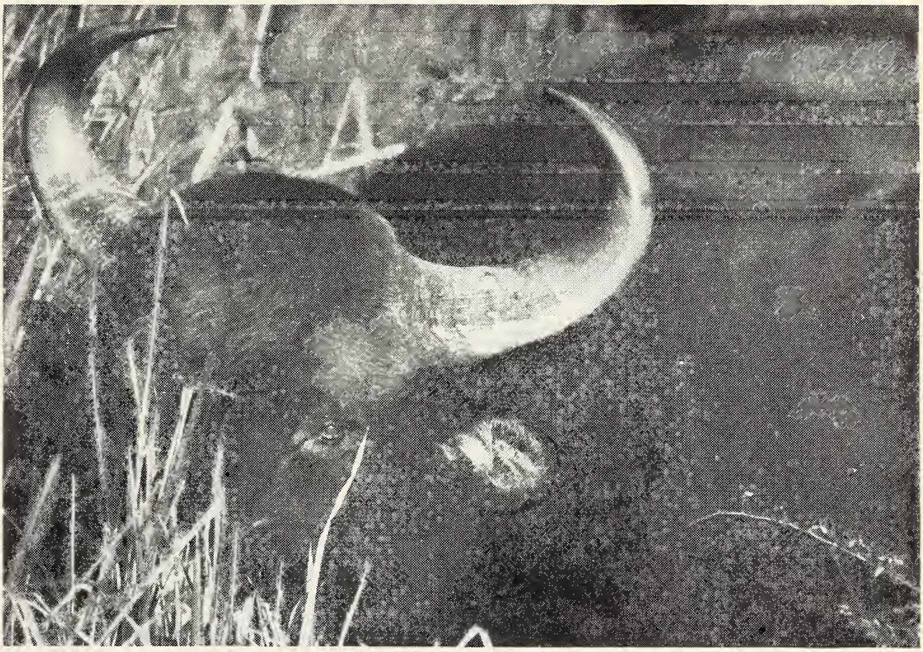


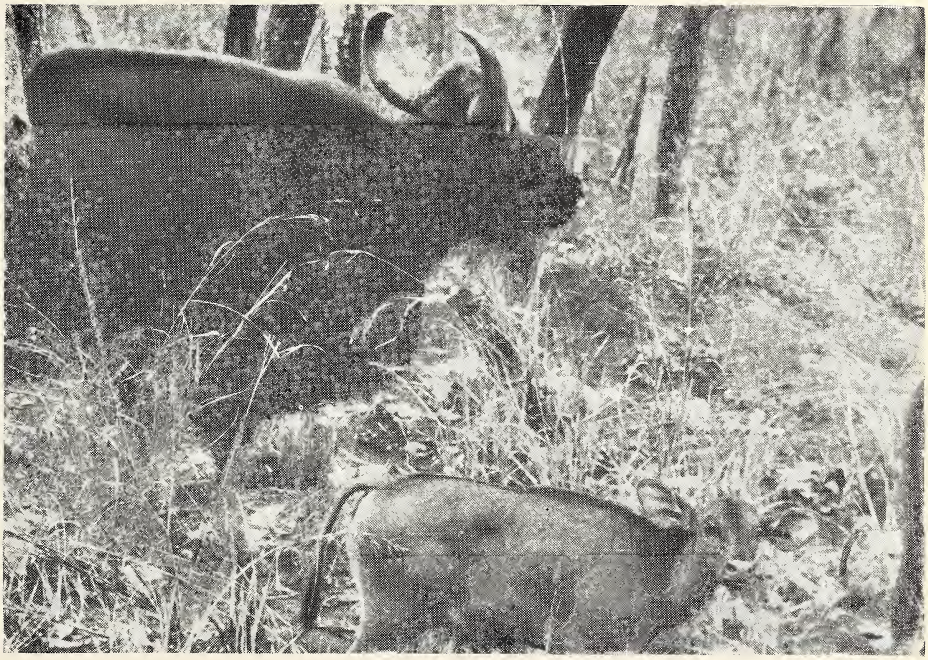


Above : TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 18 — p.m. : Old back-going lone bull gaur — TN. 10 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 19 — p.m. : Gaur herd scenting rain — TN. 11.

(*Photos : M. Krishnan*)

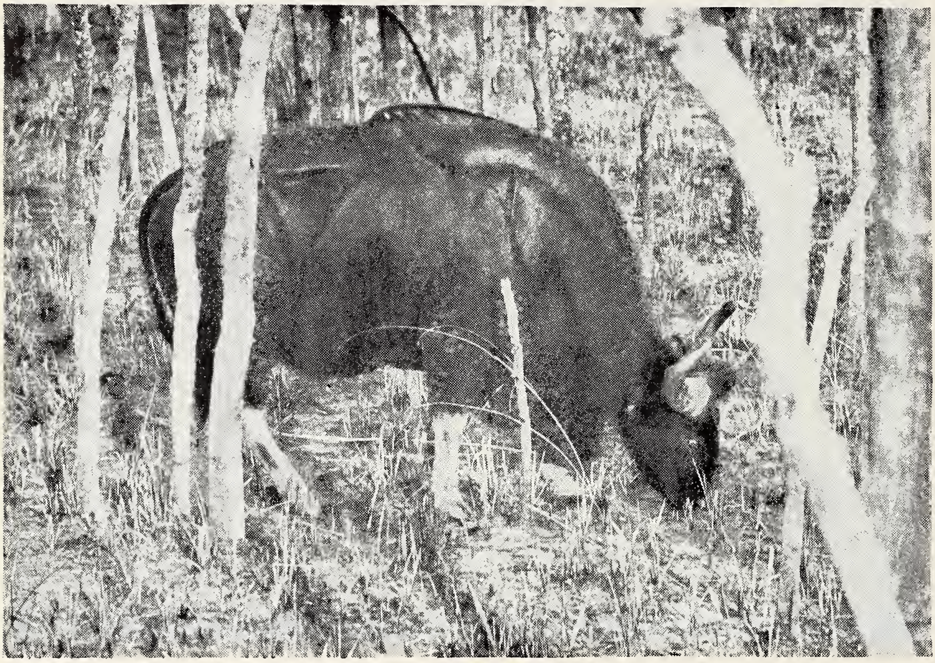
Krishnan : Mammals

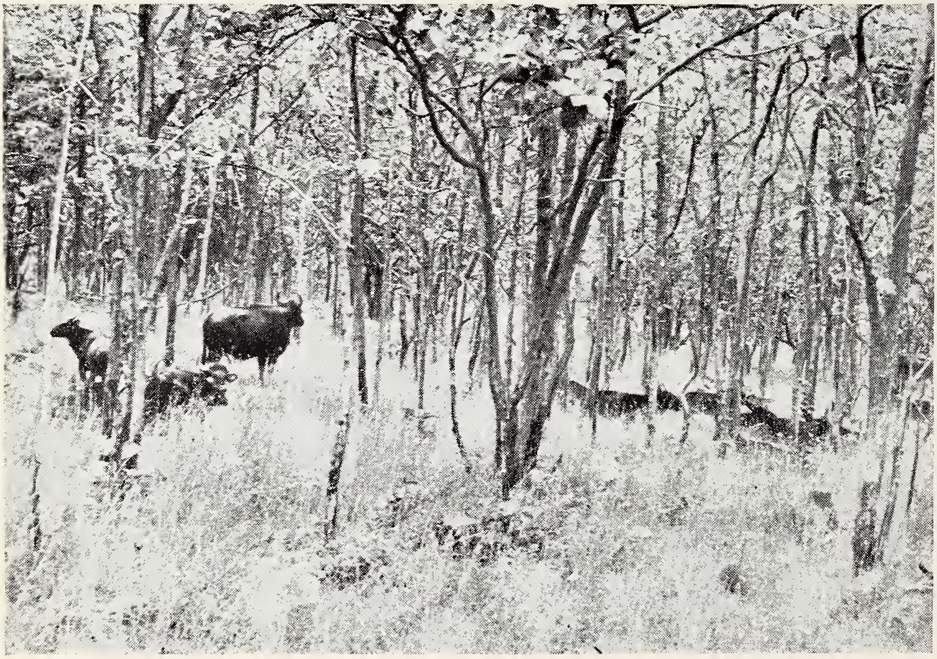




Above : TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 23 — a.m. : Lone bull gaur in the reeds — TN. 13 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 24 — p.m. : Gaur herd-bull and calf — TN. 15.

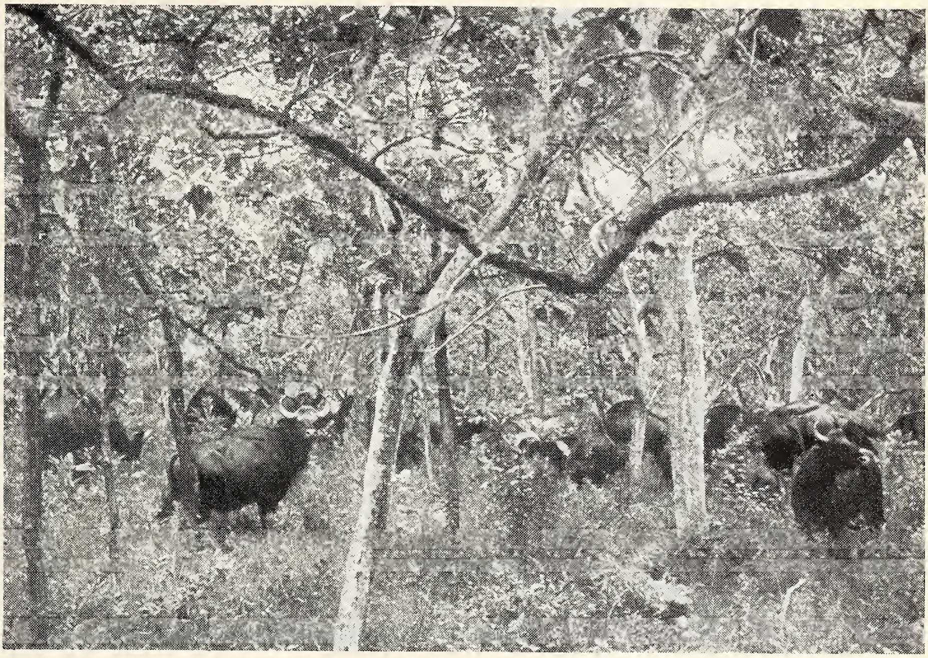
(*Photos : M. Krishnan*)

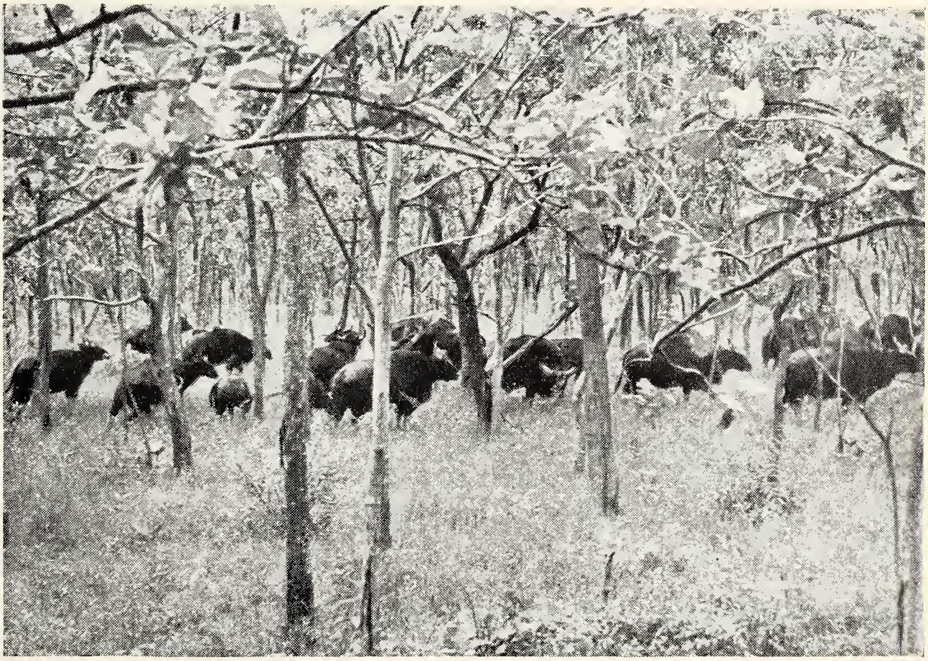




Above : TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 26 — a.m. : Old lone bull — TN. 16 ; *Below* : TAMIL NADU 1962 : MUDUMALAI SA. : Theppakkadu : September 17 — past 11 a.m. : The gaur herd lying down — TN. 18.

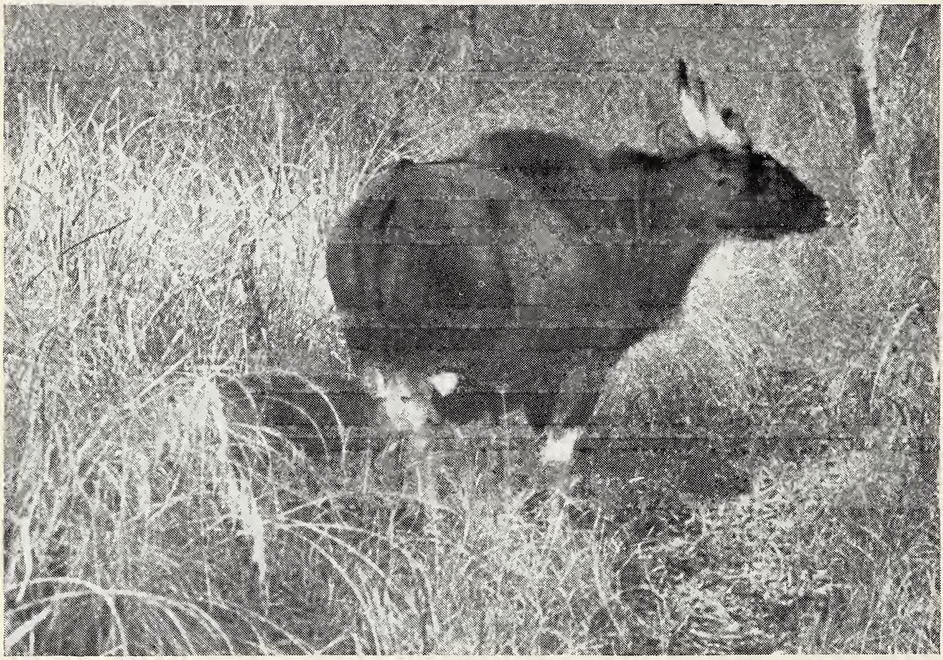
(*Photos : M. Krishnan*)

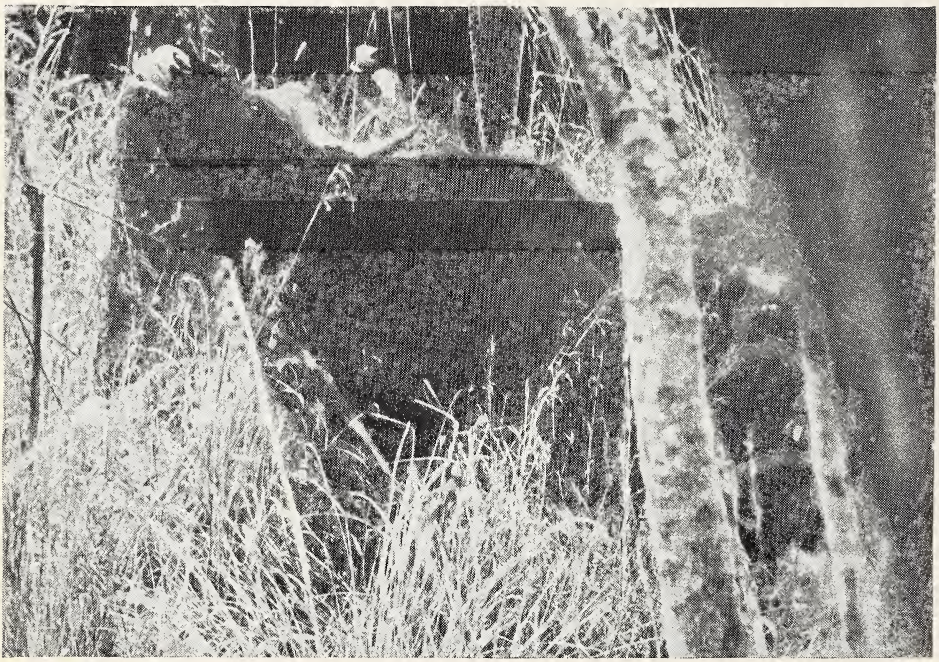




Above : TAMIL NADU 1962 : MUDUMALAI SA. : Theppakkadu : September 17 — noon : The herd with the big brown cows — TN. 19 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Theppakkadu : September 17 — p.m. : part of the composite herd of 40 gaur showing 2 herd-bulls together — TN. 20.

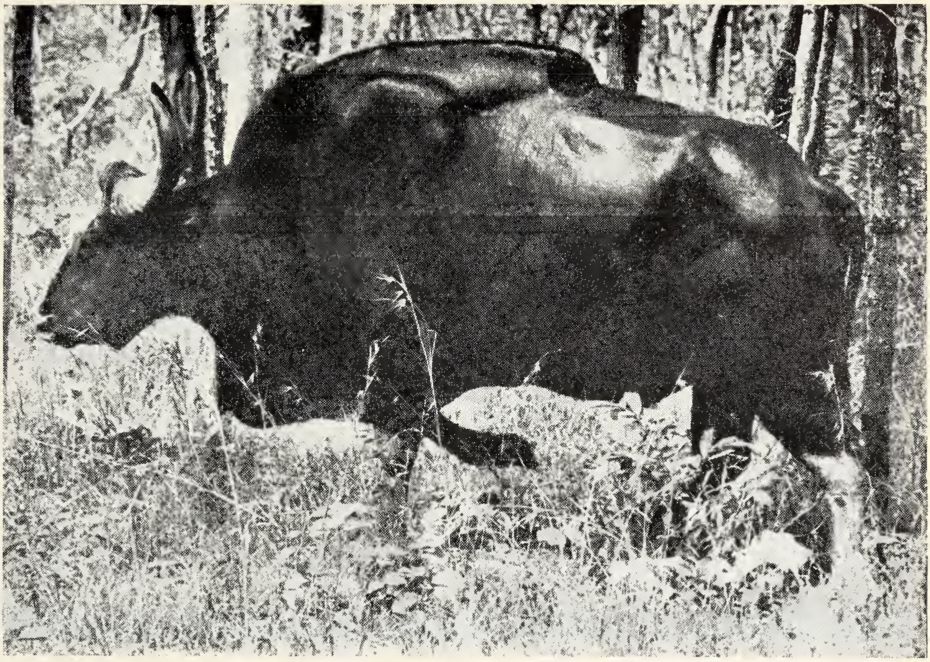
(*Photos : M. Krishnan*)

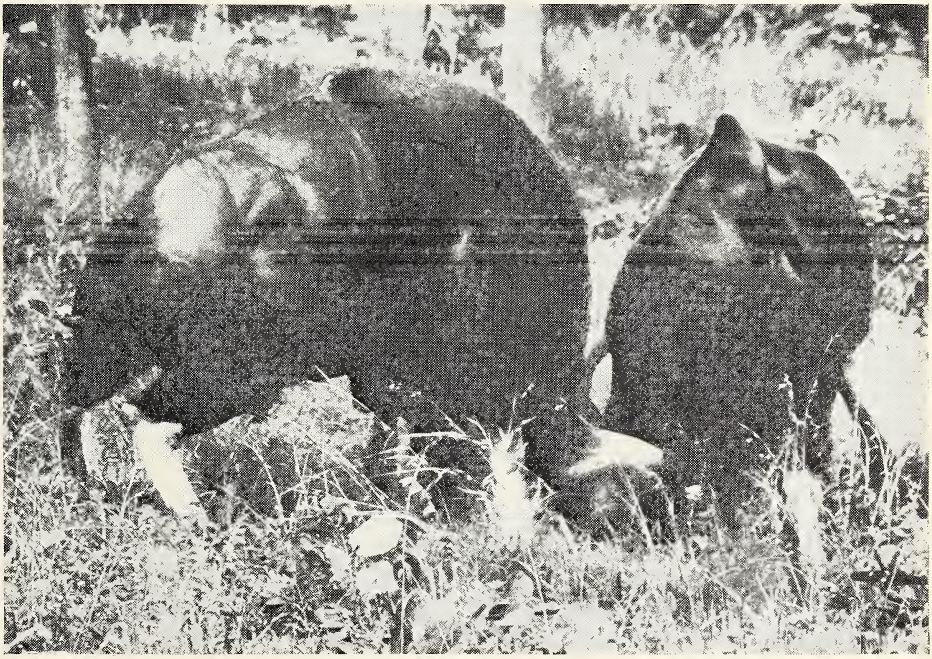




Above : TAMIL NADU 1963 : MUDUMALAI SA. : Kargudi : March 17 — p.m. : Gaur cow with newborn calf — TN. 22 ; *Below :* TAMIL NADU 1963 ; MUDUMALAI SA. : Kargudi : March 25 — a.m. : Gaur cow eating nelli — TN. 24.

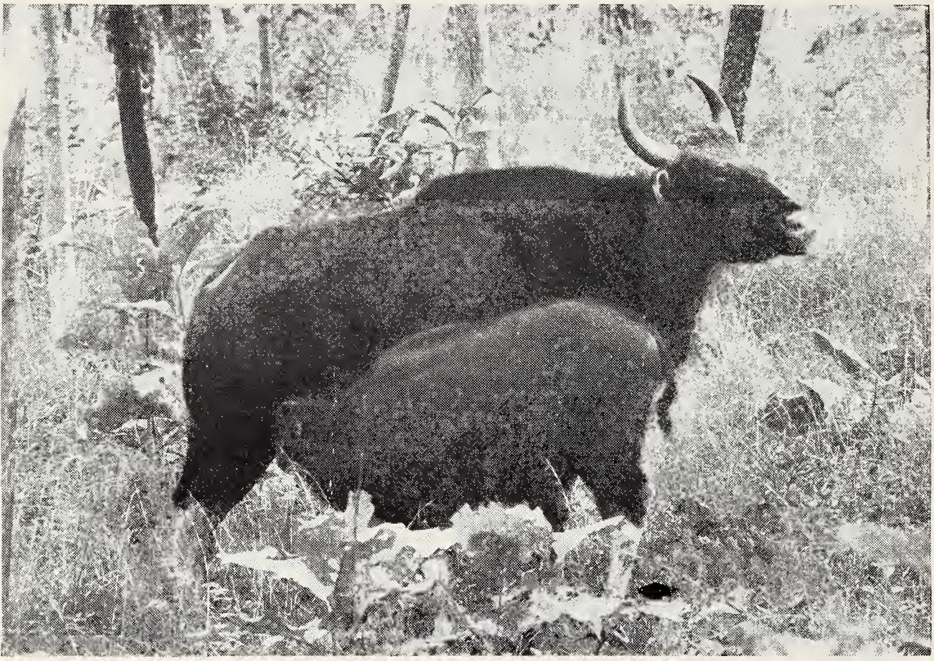
(*Photos : M. Krishnan*)

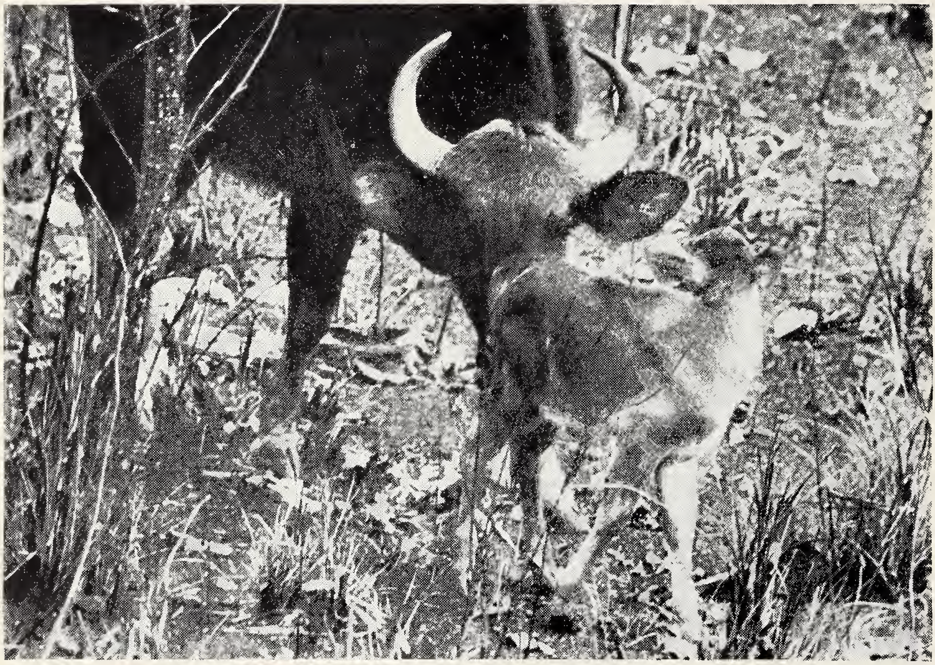




Above : TAMIL NADU 1963 : MUDUMALAI SA. : Theppakkadu : September 27 — a.m. : The bull with the Roman nose and the cicatrix — TN. 30 ; *Below :* TAMIL NADU 1963 : MUDUMALAI SA. : Theppakkadu : September 27 — p.m. : Gaur bulls fighting — TN. 31.

(*Photos : M. Krishnan*)

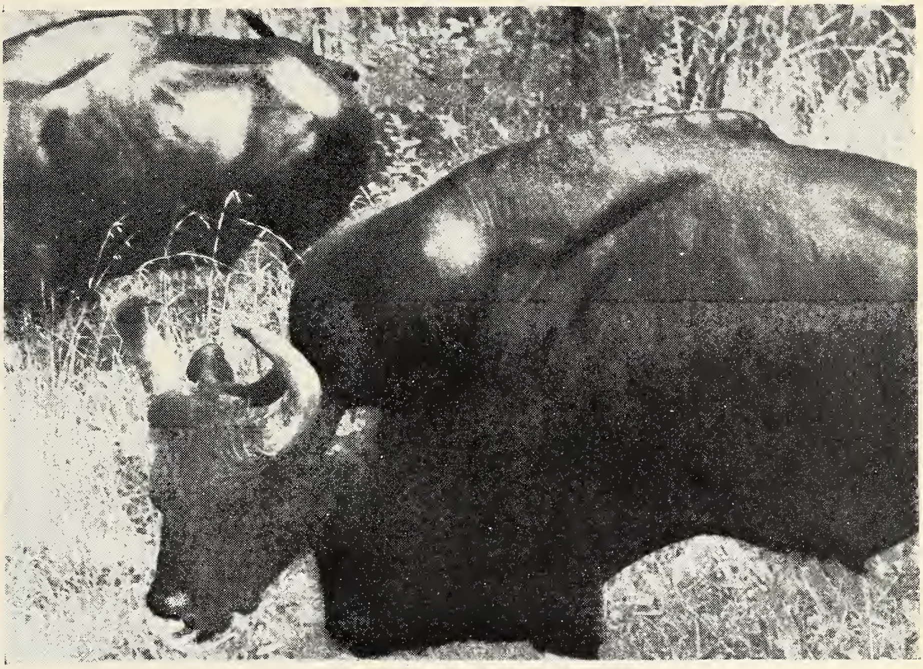


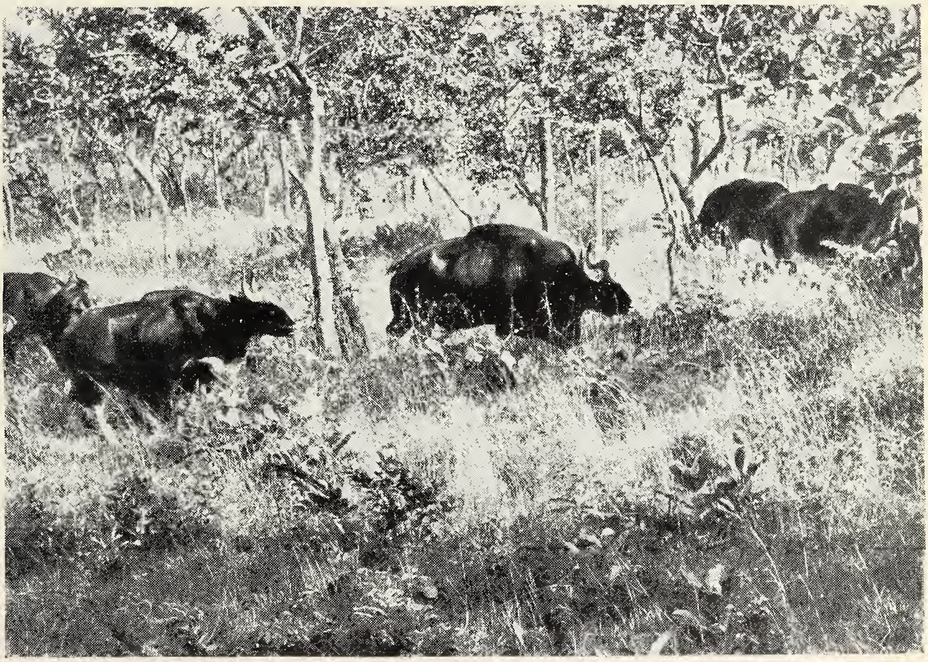


Above : TAMIL NADU 1963 : MUDUMALAI SA. : Theppakkadu : September 27 — p.m. : Gaur cow suckling grown calf — TN. 32 ; *Below :* TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : April 8 — a.m. : The cow licking her infant calf to lure it away from Vikrama — TN. 36.

(*Photos : M. Krishnan*)

Krishnan : Mammals

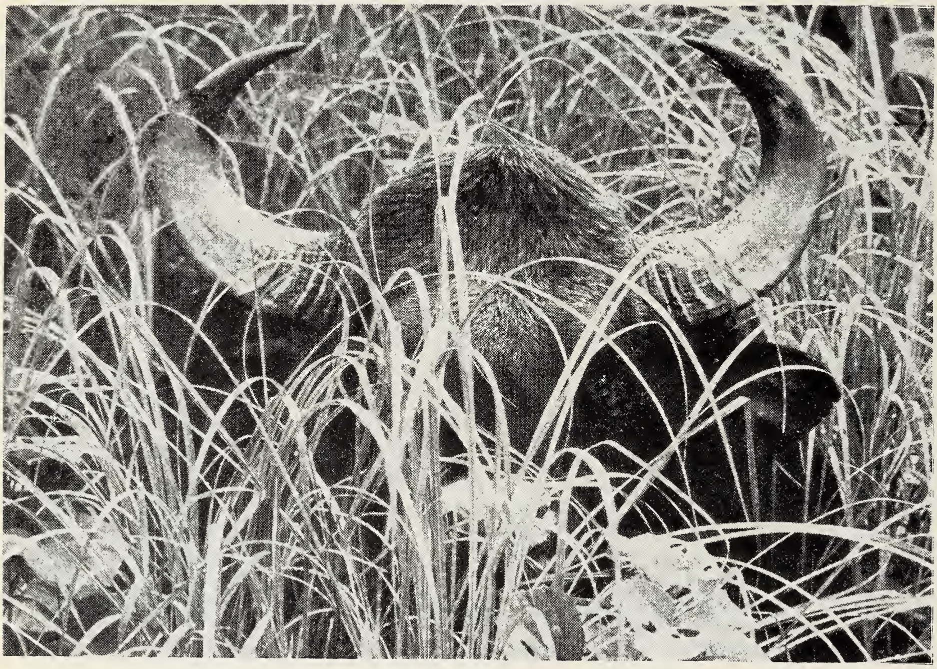


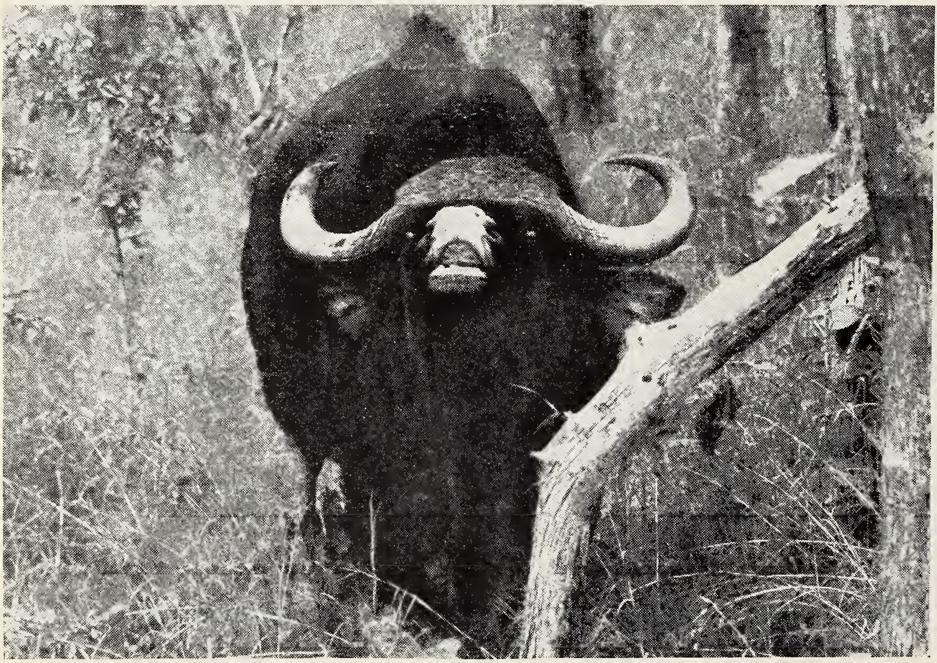


Above : TAMIL NADU 1964 : MUDUMALAI SA. : Theppakkadu : September 25 — a.m. : The bull with the Roman nose and the cicatrix in the background, and in the foreground the other bull—note hump and dorsal ridge of foreground bull — TN. 39 ; *Below* : TAMIL NADU 1964 : MUDUMALAI SA. : Theppakkadu : September 28 — p.m. : The big herd-bull, near the Mysore border — TN. 40.

(*Photos : M. Krishnan*)

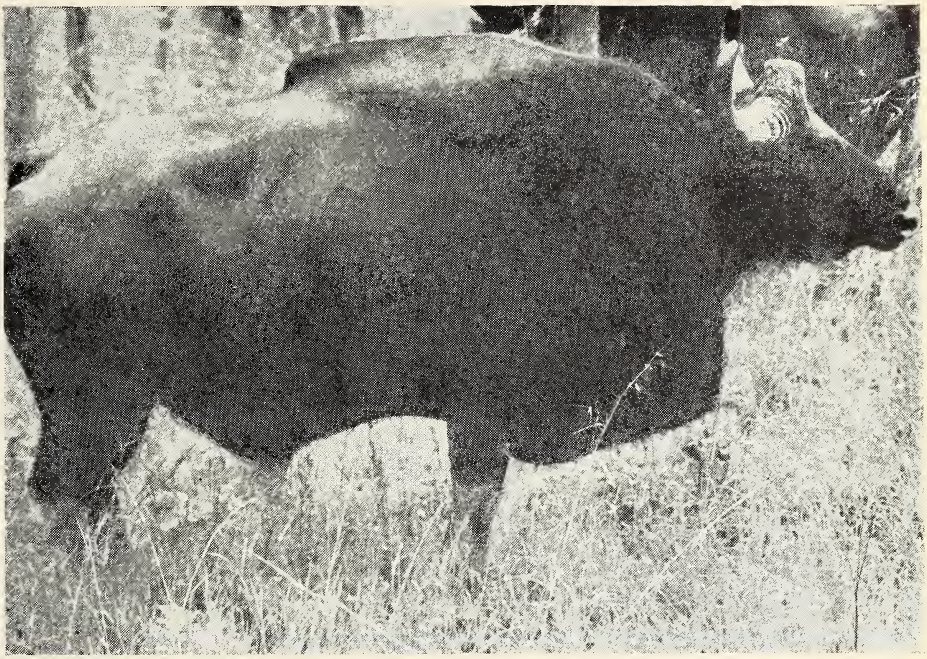
Krishnan : Mammals

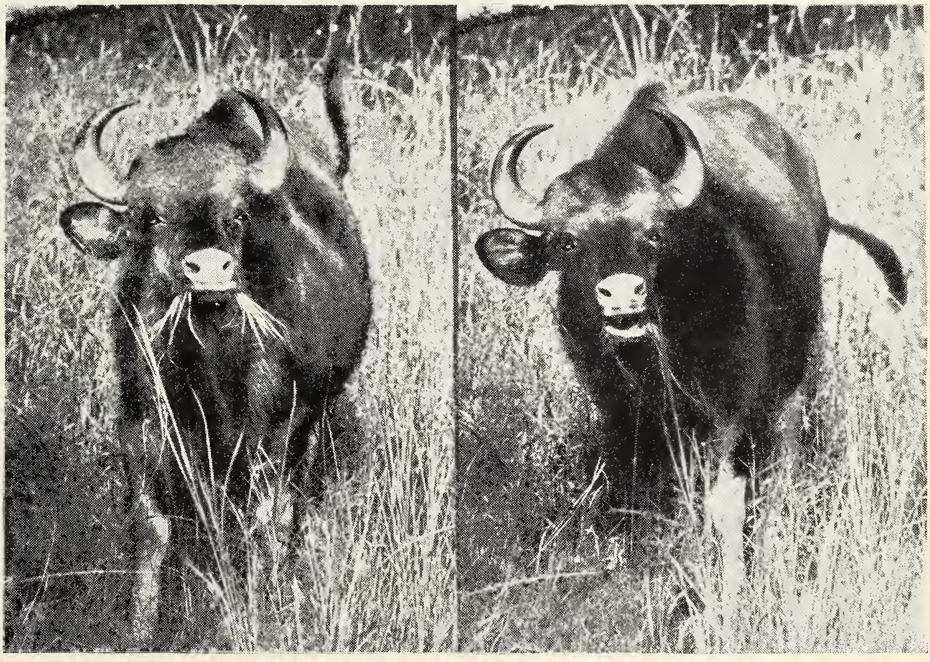




Above : TAMIL NADU 1966 : MUDUMALAI SA. : Kargudi : September 26 — a.m. : Lone bull gaur lying up in grass — TN. 47 ; *Below :* TAMIL NADU 1966 : MUDUMALAI SA. : Theppakkadu : October 2 — p.m. : Bull gaur calling to the herd : this was the biggest bull I have ever seen — TN. 48.

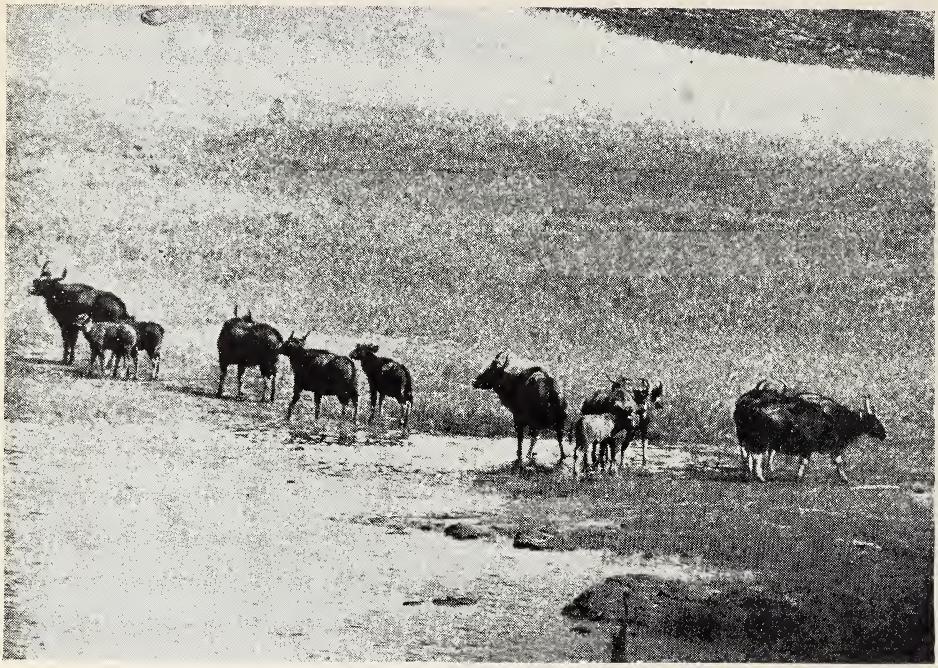
(*Photos : M. Krishnan*)

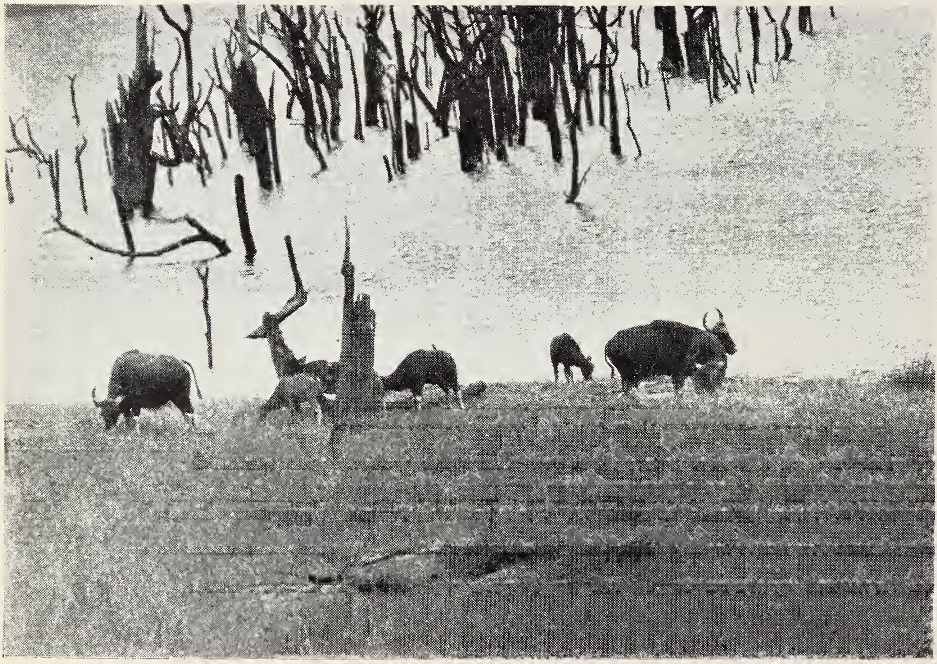




Above : TAMIL NADU 1966 : MUDUMALAI SA. : Theppakkadu : October 2 — p.m. : Close-up of the second biggest bull in the composite herd : note mass and musculature and compact build—TN. 49 ; *Below :* TAMIL NADU 1958 : MUDUMALAI SA. : September 30 : Gaur cow grazing — TN. 63.

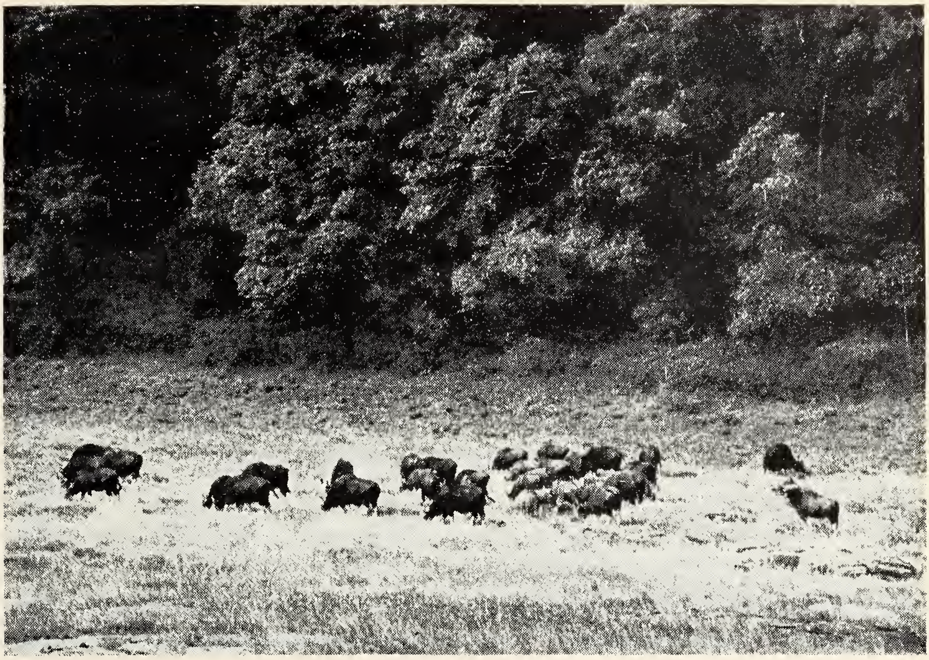
(*Photos : M. Krishnan*)

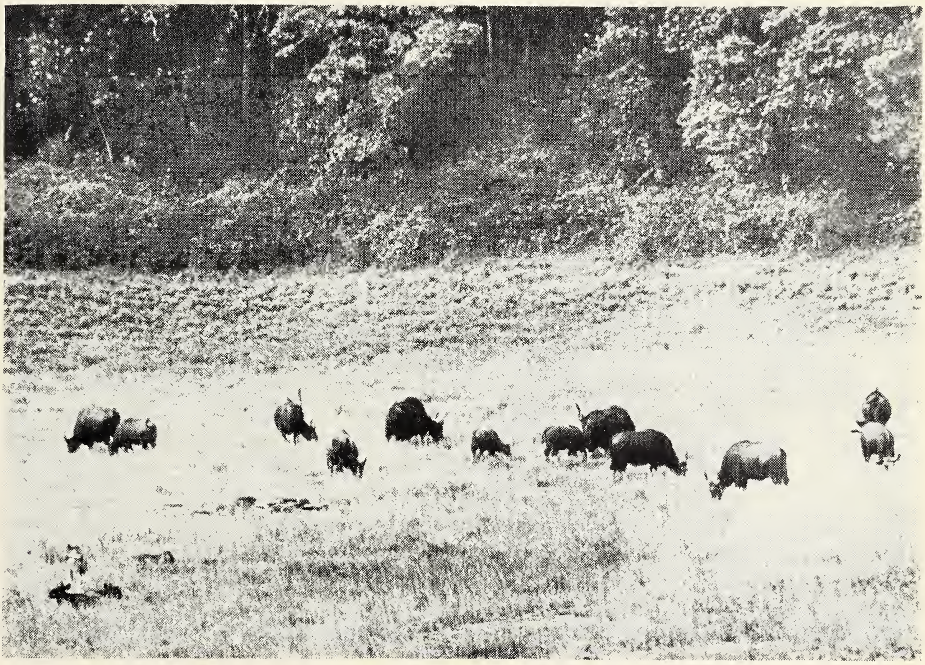




Above : KERALA **1960** : PERIYAR SA. : April **14** — close on noon. Gaur at Aiyappan Kurukku. Note build of adult cows and light colour of young calves — K. 7 ; *Below :* KERALA **1970** : PERIYAR SA. : April 29 — p.m. : Gaur at Aiyappan Kurukku — K. 19.

(*Photos : M. Krishnan*)

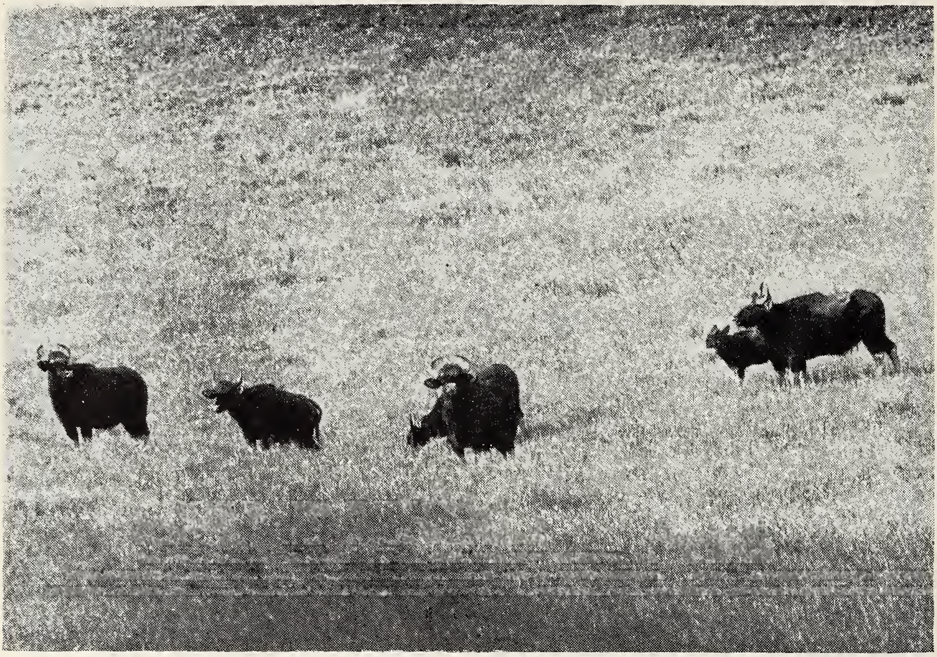


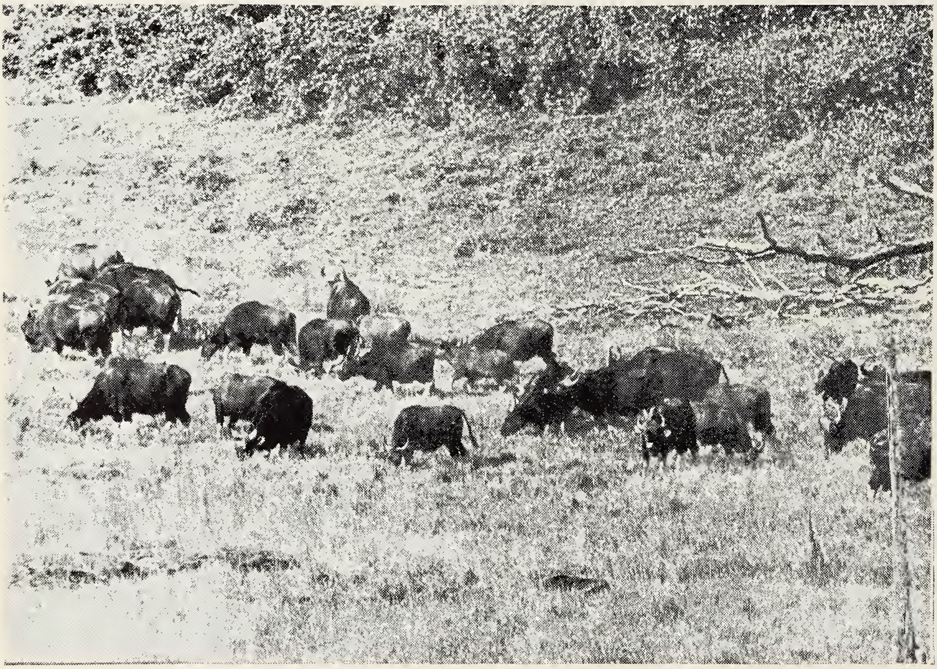


Above : KERALA 1970 : PERIYAR SA. : May 7 — p.m. : The herd of gaur at Aiyappan Kurukku — K. 31 ; *Below :* KERALA 1970 : PERIYAR SA. : May 7 — p.m. : Part of the herd of gaur, showing the young calves lying up bottom left — K. 32.

(*Photos : M. Krishnan*)

Krishnan : Mammals

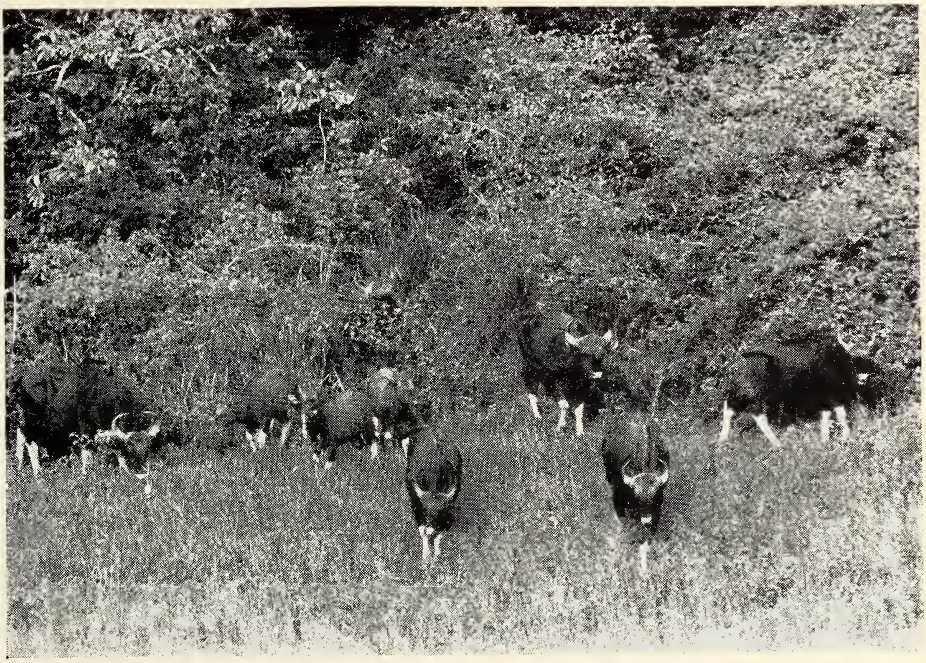


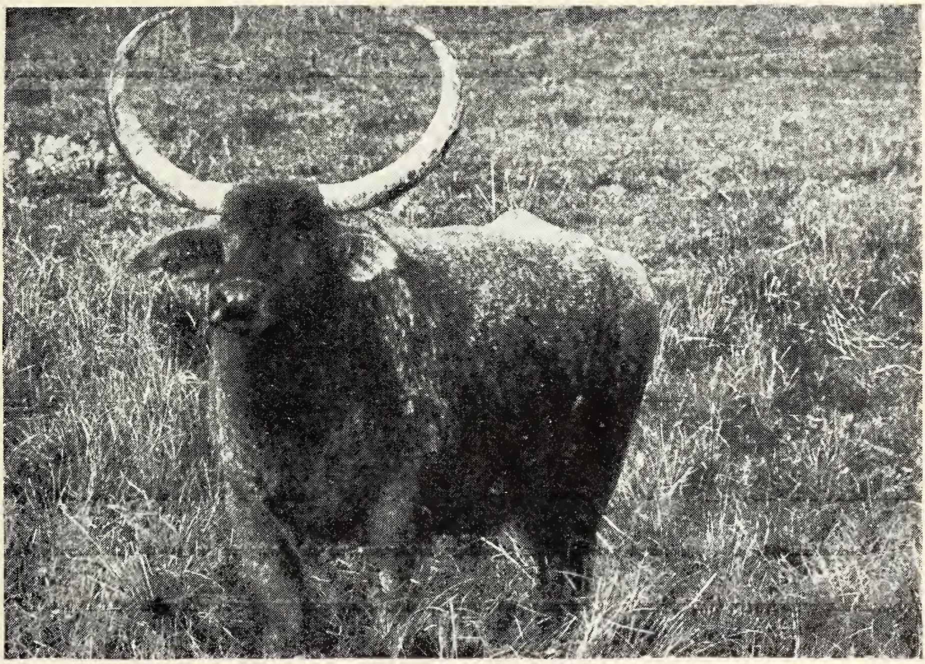


Above : KERALA 1970 : PERIYAR SA. : May 7 — p.m. : Cow looking up at me — note the other 2 cows looking at her — K. 33 ; *Below :* KERALA 1970 : PERIYAR SA. : May 7 — p.m. : Close-up of a part of the herd — K. 34.

(*Photos : M. Krishnan*)

Krishnan : Mammals





Above : KERALA 1970 : PERIYAR SA. : May 9 — p.m. : Gaur coming out of cover — K. 42 ; *Below :* ASSAM 1968 : Mihimukh, Kaziranga Sa. : February 3 : Wild buffalo cow with the semicircular type of horn — MISC. 4-A.

(*Photos : M. Krishnan*)

length than sportsmen measuring it between pegs do when it is dead. It is further worth noting that knowledgeable sportsmen also took other measurements, such as the girth around the forearm and the circumference of the head, when they had shot a really big tiger, the better to indicate its exceptional size, but that they seldom measured its height. Even if they had measured the height, no reliable figures would have resulted, in view of the toes in death pointing downwards, without the weight of the body on them.

How accurate is the determination of the height of a dead gaur, as measured by those on whom our faunal literature relies ? Many years ago, I tried an experiment to answer this question, measuring the height of a domesticated performing bullock (the zebu or *Bos indicus*, a species with which the gaur will interbreed, though it has contributed nothing to the evolution of the zebu) both when it was standing on level ground and when it was made to lie down on a flank with its forelegs held straight out. Repeated measurements gave differing figures for the height when the animal was lying down on a side and it was found that the lift of the foreleg (that was uppermost) from the ground, the flexion of what corresponds to the fetlock in a bullock, and the convex curvature of the shoulders and hump all materially influenced accuracy in measurement: the measurement between pegs differed from the measurement with the tape held straight over the curves, and standing height was less by an inch from the least lying-down height. The measurement of the height of such a massive animal as the gaur should present even greater difficulties and will depend materially on how the animal has fallen down in death. One further point may also be mentioned here. The conversion of the measurements recorded in feet and inches into centimetres by multiplying the total in inches by 2·54 only magnifies the error by 2·54; however, such a conversion does invest what is intrinsically a rough measurement with the verisimilitude of scientific exactitude. All this is detailed at such tedious length only to make the point that such measurements as we have of the height of most wild animals are approximate, though they are probably near approximations to the truth.

A big gaur bull may stand over 6-foot high to the top of the dorsal ridge and weigh almost a ton. Prater gives the height of adult bulls on an average at about 5-foot 9-inch, and adds that adult cows are about 4 inches lesser in height. Considering the great mass of the body, the difference in height between a big cow and a bull is not readily appreciable, and in forest lighting and in the forest setting the other differences between the sexes, such as the larger dorsal ridge and fuller dewlap and the more divergent and massive horns of the bull, are not clear either, as the number of adult cows shot by sportsmen licensed to shoot bulls will testify. Schaller gives the height of the bull at 64 to 72 inches and the length at from 11 to 12 feet, and adds that the cows are 'considerably smaller', a statement that is true for the Kanha N. P. area where he made his observations.

Bulls with massive, divergent horns (photographs TN 1, TN 48) are easily distinguished as bulls by their horns, but in many adult bulls the horns are not widely divergent and not so obviously different from those of big cows TN 62 Mar. 20 and 28—photographs TN 4, TN 10, TN 15). Height *per se* is no more reliable an indication of size in gaur than in elephants: some bulls are very long in the barrel though low-to-ground in build, so much so that they can be picked out from other gaur in a herd easily by this bodily peculiarity (TN 62 Mar. 24, 66 Apr. 20).

While undoubtedly there is no case for the distinguishing of different subspecies of gaur on the basis of size and colour, there do seem to be two main 'kinds' (a weak word, it is realised, but no better term is available) of gaur in peninsular India. Since these are often found together in different herds in the same area, and sometimes even mixed in one herd (as when a composite herd breaks up in some confusion and before it reforms), no taxonomical distinction between the two can be attempted, but it should be stated that there do appear to be two main 'kinds', leaving out the light-coloured gaur said to be found in a part of Tamil Nadu.

Regarding these two kinds, the following general statements appear to be valid. The smaller kind is distinguished by the cows being noticeably smaller, and square-built, with much black hair on the throat and generally of a darker and more sooty colour, and having smaller and straighter horns (horns not formed in a semilunar curve, but more like that of some short-horned domestic zebu): the adult bulls in the two kinds differ little, except that in the smaller kind the adult bulls appear to be invariably black when full-grown, and are of smaller relative size. The disparity in size between the sexes is most noticeable in the smaller kind and further, the young calves tend more to be of a brown-pink colour at birth than a golden fawn. Throughout the north of the peninsula, in Orissa, Bihar and Madhya Pradesh, I saw only this smaller kind: I did not have adequate opportunity to form any opinion on the gaur of Maharashtra or Andhra Pradesh, but these, too, are probably mainly of the smaller kind. In Mysore and Tamil Nadu both kinds are to be seen, and in Kerala I saw only the larger.

Many adult bulls of the smaller kind were quite small in size and appeared smaller than a full-grown cow of the larger kind—in fact, they were not much larger than the adult cows with them (MP Mar. 17 and 20—photographs MP 34, MP 37 and MP 38). Further, the tendency to somewhat disproportionately long barrels in some bulls (already detailed) was observed only in this kind. Field notes and photographs, some of the latter specially taken to display the features of the cows, provide a fuller description : TN 62 Sep. 13, 14, 15, 16, 17 and 63 Apr. 5 ; O 69 Jan. 19 and 26 ; B 68 Apr. 20, 28, 69 Feb. 3/4 and 5/6, 21, 22, 70 Feb. 24 and Mar. 1 ; MP 68 May 2, 3 and 4—photographs : typical cows : TN 32, O 1, B 34 and B 37, MP 37 : typical bulls : B 3, B 4 and B 5 : herd : TN 18 and TN 20.

The larger kind has already been described comparatively. It is sufficient to add that some of the most impressively large bulls of this larger kind are not black, but a deep vandyke brown or a very dark burnt umber in colour (TN 64 Sep. 28, 66 Oct. 2—photographs TN 40 and TN 48) : some very big bulls are also black (TN 59 Mar. 9, 12, 16 and Apr. 2 ; K 70 May 7—photographs TN 1, K 31). Descriptions in field notes and photographs of typical cows are provided in K 60 Apr. 14, 16, K 70 Apr. 19, 20, 22, 29, May 1, 4, 6, 7 and 9 : TN 62 Sep. 17, 22; TN 64 Mar. 31, Sep. 28; TN 66 Sep. 28 and Oct. 2; TN 70 Sep. 15 and 21—photographs K 7, K 31, K 32, K 33 and K 42 ; TN 19, TN 40, TN 48 and TN 49). Calves are usually a golden sienna in colour in their infancy.

In the Theppakkadu area of the Mudumalai Sanctuary, where composite herds can be seen in September-October, sometimes the two kinds may be seen in loose association. I am not definitely sure whether or not there is a decided tendency for the two kinds to stay apart normally, my studies into this question having been frustrated by the epidemic of rinderpest that broke out in 1968 and which resulted in my seeing no gaur at all either in the Mudumalai or in the Bandipur sanctuaries in 1968, 1969 and 1970 (except for a few small parties seen in the Mudumalai Sa. in September 1970).

Sometimes an animal from a herd of one kind does get into a herd of the other kind, as detailed in the field notes referred to, but such an association seems to be purely transient.

It is true that in between these two distinct kinds there are parties and herds intermediate in character, so that the distinction may seem idle, but there is sufficient constancy of relationship between size and colour in these two kinds, especially in the cows, to warrant such a distinction.

Distribution

Gaur have been affected even more than elephants (the two are often found in the same forests) by the dwindling of the forests and human invasion of their old haunts. Apart from this, they have been seriously affected from time to time by epidemic diseases like rinderpest and murrain through infected cattle grazed in the forests—in fact, no wild animal in India has been so profoundly influenced by infections from domestic stock as gaur. Further, the indiscriminate shooting of gaur for 'sport' (licensed and unlicensed) and their hunting by tribals (as in Bastar) has led to the decline or extinction of small local populations. For these reasons, the distribution of gaur has altered materially in places during the past 30 years, and accounts of their distribution as it obtained in the forties are no longer valid in many areas. Schaller, in his chapter on gaur in THE DEER AND THE TIGER provides an admirable account of their present distribution, but this, based almost entirely on information provided by others, is in need of amplification, as he himself realises.

Comparing the present distribution of gaur as plotted by him on a map of India with a vegetation map of the country, he says that 'the animal is largely confined to the evergreen, semi-evergreen and moist deciduous forest areas but ...... it has also penetrated the dry deciduous forests at the periphery of its range. The apparent preference of gaur for hilly terrain may in part be due to the conversion of much of an earlier habitat in the plains into fields, whereas the hills have until recent years been left relatively undisturbed'.

The shikar literature of South India of the last century and the early part of this century, when there were still plains forests in the region, does not suggest that the preference of gaur for hilly and hill-side terrain is a consequence of human occupation of the plains forests; there is some evidence in classical Tamil (about 18 centuries old), which is quite familiar with the plains forests, to show the preference of gaur for hill-forests, but while all this is no doubt interesting it is entirely irrelevant in this report which is concerned mainly with the present, especially when the past does not disclose that gaur were ever common in the plains forests.

Gaur are not animals of the evergreen forests. In the north of the peninsula they are found today mainly in the deciduous and semi-deciduous (the latter may be termed semi-evergreen as well, considering that the word 'semi' connotes a half, strictly construed) hill-forests and forests around such hills; in the south of the peninsula, there are no large belts of evergreen forests anywhere in the areas where gaur are to be found: pockets and patches of evergreen vegetation alternate with deciduous forests, elevation, rainfall and edaphic factors being the main influences determining the formation of such evergreen areas.

Today, in spite of the great losses caused by rinderpest in 1968, more gaur are to be found in the south of the peninsula than in the north, and in the south, their distribution follows the low-elevation hill-forests and is fairly extensive. Schaller cites my authority for the statement that there are probably 300 to 400 gaur in the Mudumalai Sanctuary. Apparently I failed to make it clear, in providing this opinion, that there is no large permanently resident population of gaur in that sanctuary and that gaur move from the area into the adjoining Mysore and Kerala areas, and from them into the Mudumalai area again. It is difficult to estimate the total number of gaur in this vast and varied stamping ground which must be one of the best areas for gaur in the world, but it is certainly far in excess of 400, many times that. Schaller provides the information that there are two isolated populations of gaur 'along the Madras-Kerala border in the Anaimalai Hills and around Periyar Lake'. There are certainly more than two isolated populations in this considerable area.

Gaur are far-ranging animals, moving in herds (and in composite herds at times, especially when shifting ground) over a considerable forest area as seasonal needs require them to. For this very reason, because they need extensive grounds, and because the forests are now much less continuous than in the past, their distribution is discontinuous today.

Habits : *Behaviour*

Most of the field observation of gaur was done during the day from elephant back in various parts of the Mudumalai Sanctuary of Tamil Nadu, mainly in the Kargudi and Theppakkadu blocks of that sanctuary. In Orissa, Bihar and Madhya Pradesh gaur were seen both by day and (more commonly) by night, mainly from a jeep or hide. In observing gaur from elephant back a fairly fluid technique of approach was used, which often led to the gaur accepting the riding elephant (with the men atop) and going about their affairs as if we were not there (TN 59 Mar. 26). In this manner it was possible, moving slowly with the moving herd, to follow it for hours or even throughout the day, and observe the gaur from close quarters, though it was seldom possible to raise oneself adequately high (to sit up, for example) for taking photographs without alarming the animals: incidentally, conversation in low tones, limited to a few necessary instructions, had absolutely no effect on them, once we were right in the herd and had been accepted (TN 59 Mar. 26, 62 Sep. 14, 17, 63 Mar. 17, 26, 63 Sep. 13, 16, 25, 63 Oct. 1, 64 Sep. 22, 23, 25, 66 Sep. 28).

Dunbar Brander's statement that gaur are essentially animals of extensive forest that 'avoid man and all his works as much as possible' is profoundly true. Where they are not much disturbed by men, they are diurnal in the main, although they do feed for some time at night. In areas where their activity is mainly diurnal, they feed and are on the move till late in the morning, and then lie up for a siesta during midday. They are up again in the afternoon, and towards evening often seek a clearing: they lie up again for awhile at night, feed again, and are generally to be found lying down again by about midnight. This is a generalised composite account based on observation of gaur both by day and by night, in areas where they are not much disturbed, though the field notes refer only to daytime observations. Where they are subject to disturbance by men during the day, as in most areas in Orissa, Bihar, Madhya Pradesh and Maharashtra, as also Andhra Pradesh, they come out mainly at night, turning crepuscular and nocturnal and naturally their feeding and other activities are continued later into the night. Even so, gaur were observed to be lying up chewing the cud by about midnight (O 69 Jan. 25, 27 ; B 69 Feb. 21, 70 Feb. 24).

Apparently, gaur have changed their habits in areas within the past 50 years. Dunbar Brander writes of them as animals he has seen and watched by day, but Schaller found them largely crepuscular and nocturnal in the same or similar area.

During the hottest part of the day, gaur generally lie down; animals in a herd choose some shady spot, and usually favour a hollow, well covered with grass, for the siesta (TN 62 Sep. 14, 17, 63 Mar. 12—photograph TN 18). Lone bulls lie up in tall grass, or at times in bushy cover (K 60 Apr. 11 ; TN 66 Sep. 26—photograph TN 47). I noticed in 1958 that in parts of the Mudumalai Sanctuary where lantana grows in a continuous thick belt, the gaur had tunnelled regular dormitories in the cover and slept in them by day, both small parties and solitary bulls (TN 62 Mar. 14).

Dunbar Brander gives this account of the seasonal wanderings of gaur: 'During the cold weather they frequent grass maidans on hill tops, and the bamboo and creeper-clad slopes of the hills. As the hot weather advances, shortage of water and food forces them down, and they can then be found at lower elevations, frequenting grassy glades or the banks of streams. In the rains they wander much, but during other seasons they frequent the same places at the same time year after year'.

Seasonal movements noticed in the Mudumalai Sanctuary followed the rains, the rank growth of the undershrub after the monsoons, especially the tall grasses, the desiccating heat of February-March and the withering of the grass, and the lack of foliage and shade in the deciduous tree forests. Although the perennial waters of the Moyar attracted elephants to the vicinity of the river in summer, the gaur were not drawn to the river and to the surrounding Theppakkadu and Moyar areas so much as to the interior forests of Kargudi, Mudumalai and the base of the steep hill, Markundarai Betta near Theppakkadu: comparing the elevation, there is a difference of only a few hundred feet between the flatter terrain of the riverside forests and the more hilly ground of the other areas but the ground vegetation is low in the riverside forests, whereas there are belts of tall grass at Kargudi, and 'gaddes' (swampy areas), and the tree forests are generally taller and less entirely leafless in Mudumalai, where also there are swampy areas and belts of bamboo (TN 59 Mar. 12, 15*, 16, 26*, 31*, 62 Mar. 24*, 62 Apr. 7 & 9, 63 Mar. 12, 19, 63 Apr. 1*, 2, 5, 64 Mar. 16, 17, 23, 28, 31, 64 Apr. 8*, 66 Apr. 20, 21, 23). During the heat of midday, the gaur in herds generally lay down in tall grass or sought the shade of the more leafy trees along the dry and semi-dry nullahs, but even when the sun was hot they were moving through the shadeless, leafless tree forests—the references to the field notes above marked with an asterisk denote such occasions (photographs TN 7, TN 14). They found the water they needed at shallow pools and semi-dry nullahs, as at Imbarhalla, and were often found in tall grass belts where the tree growth was sparse. Apparently what attracted them to these forests was the fresh tall grasses coming up and regenerating herbs, as also the new leaf of some trees.

In September-October, when the tall grass was rank and very high, and when the ground vegetation was also coarse, and the flies were specially abundant in such cover (TN 62 Sep. 12, 63 Sep. 14, 64 Oct. 6), gaur were to be seen only in the open clearings in certain parts of Kargudi (compartment 2 and from it to near Abhayaranyam) and in the Theppakkadu and Moyar areas. Near the river, then, the ground vegetation of the forests was lush and low, and gaur were sometimes seen in lantana patches, but not in tall grass belts (TN 62 Sep. 13 to 17, 22, 63 Sep. 12 to 17, 22, 25, 27 and Oct. 1, 64 Sep. 21 to 25, 28, 70 Sep. 15, 19 and 21—photographs TN 18, TN 20, TN 40). During late September and in October, gaur tend to move out of the Mudumalai sanctuary to other areas around, notably to Bandipur which is not on a lower elevation, but where the forest is more open and level and there is little tall grass, but plenty of lush short grass. It is to be noted that it is not as if there is a general exodus of the gaur from the Mudumalai sanctuary to Bandipur and other surrounding areas in these months; some herds stay on in the Mudumalai Sanctuary, as at Masinagudi and in Kargudi.

It will be seen that these observations are diametrically opposed to what Dunbar Brander has said, but that only shows how profoundly the behaviour of the same animal can differ in different settings (Madhya Pradesh is very different from Mudumalai in its vegetation, terrain and in the extreme climatic contrasts between summer and winter there) and how risky it is to draw inferences on the general behaviour of an animal from observation of it in one particular habitat.

Gaur are given both to grazing and browsing: their main fodder is various kinds of tall and short grasses, and a number of ground herbs and small shrubs, such as *Hibiscus lampas*, *Grewia aspera* and

G. hirsuta, *Helicteres isora*, *Butea parviflora*, *Desmodium pulchellum* and *Costus speciosus* (K 70 May 7 and 9; TN 59 Mar. 9 and 13, 62 Sep. 20, 63 Mar. 19, 64 Mar. 28). Coarse, robust grasses that have matured fully are not eaten—many of these develop, with maturity, a sharp, siliceous edge to the outer margins of the leaf-blades that can cut through the skin of a man's hand. They eat the tender shoots of tall grasses coming up in summer much as they eat short grass coming up after the rains, cropping them quickly and continuously in the manner of cattle, moving along as they graze with lowered heads; but when the grass is about 18-inch high or higher, they crop it in sheaves, getting the sheaves crosswise in their mouths and raising their heads periodically to chew and swallow the mouthful (K 70 May 7 p.m., 9 p.m.—photographs K 31, K 32, K 34, and K 42; TN 62 Mar. 26, TN 66 Apr. 15—photograph TN 16; MP 70 Mar. 5—photograph MP 26) photograph TN 63, although taken prior to the period of this survey, is also included as it shows the way the grass is held crosswise in the mouth very clearly.

The foliage and soft twigs of a number of tall shrubs, trees and climbers are eaten, among them *Cordia myxa*, *Grewia tiliaefolia*, *Zizyphus trinervia* and *Z. xylopyrus*, *Emblica* spp. and *Smilax zeylanica*: special mention should be made of *Ardisia solanacea* which is eaten foliage stems and all (TN 63 Mar. 19, 25; TN 64 Mar. 28; MP 69 Mar. 8—photographs TN 24 MP 15). Gaur do not spend any time nibbling delicately at small titbits like leaf buds or flowers; they are bulk feeders and crop and ingest green fodder quickly, lying down several times in the course of the day and night to chew the cud. The tongue is extruded to curl around leaves and twigs and pull them into the mouth but not to strip leaves of branches—that is done with a bite and a tug. In areas where they are not much disturbed by humanity, most of the feeding is done by day, from early in the morning to late (about 11 a.m.) and again from about 2.30 or 3 p.m. to 5.30 p.m.

Among the fruits eaten should be mentioned *Aegle marmelos*, *Cassia fistula* (TN 64 Mar. 28), *Gmelina arborea*, the fallen fruit of *Emblica* spp. and *Terminalia bellerica*. Dunbar Brander mentions that they are fond of the fruit of *Randia dumetorum*: I have never seen gaur eating this fruit, though on 4 occasions I observed a herd pass the trees in fruit, and once a few trees of *Randia uliginosa* growing on the edge of a swampy area—that is not to question the truth of his statement.

Bamboo foliage and culms, when tender, are much eaten, and both *Bambusa arundinacea* and species of *Dendrocalamus* are browsed. Gaur are frequently unable to reach up to the foliage of the giant bamboo up the culms, but when elephants have pulled down a clump, they wait till the pachyderms have left and then feed on the bounty.

As with other herbivores, salty earth is eagerly sought out and eaten—the earth is licked when hard, but when moist and friable, bitten off. Artificial salt licks at the Ligirda watch-tower in Tholkobad (Bihar) and at Sravantal in the Kanha N.P. attracted gaur at night: at Sravantal the gaur were seen in association with chital and sambar (B 69 Feb. 3/4 and 5/6—photographs B 3, B 4 and B 5; MP 70 Mar. 12, 14, 16, 17, 19, 20 and 22—photographs MP 34, MP 35, MP 37 and MP 38).

As already said, gaur do not require large sources of water to drink, though where extensive sheets of water can be approached along level ground, as at the Taroba and Periyar lakes, they will slake their thirst at lakes. In the hill forests and even in plains forests they drink at small streams, pools and puddles, often travelling a long distance to reach the water, grazing towards it: in the Theppakkadu area of the Mudumalai Sanctuary, for example, there are two shallow pools, barely 20 feet across, and gaur in the area always come to them to drink, so that in ascertaining whether or not there are gaur in that area an inspection of recent footprints in the soft mud around these pools is sufficient to provide a reliable clue. They do not appear to drink at any fixed time of the day or night: probably they drink very late in the evening or very early in the morning, before dawn, for I have seen fresh footprints of gaur at the Madhuchuan pool very early in the morning, and also at a few other similar pools which provided the only convenient source of water within miles. They may drink early in the morning or later, about 9 a.m. (TN 63 Mar. 29; B 69 Feb. 17), at midday or in the afternoon about 4 p.m. (TN 63 Mar. 13; B 69 Feb. 22, 70 Feb. 24 and 27) or in the evening (TN 62 Mar. 16; B 70 Mar. 1). They drink deep, drawing in the water in an almost continuous draught, and take only a minute or two to quench their thirst.

They do not appear to bathe, or to wallow in mire as sambar do. Occasionally a few animals may be seen standing in knee-deep water at a pool, but they seem to distrust deep water, and cross the Moyar (in their frequent passage from the Mudumalai Sanctuary into Bandipur and back) only along certain rock bottomed shallow fords as at Kakkanhalla.

Lone bulls do not differ from gaur in herds in their feeding and drinking habits, but in the Mudumalai Sanctuary it was observed that they often kept, for weeks or even longer, to the vicinity of a small swampy 'gaddee' or a stream, not wandering far from it to graze, and no doubt the vegetation of such areas has its distinctive individuality (TN 59 Mar. 8, 12, 16, 62 Mar. 16, 23, 63 Mar. 13 and 18—photographs TN 3 and TN 13: TN 59 Mar. 9, 13, 18 and Apr. 2—photograph TN 1: TN 63 Mar. 26 and 28).

The age to which gaur probably attain becomes relevant in the context of their inhabiting the same area over a period of years. Although some cows may have a distinctive scar or other mark, or an accidental mutilation or the malformation of one or both horns, that will serve to identify them, it is the adult bulls, so marked by accident or natural peculiarity, that are more readily spotted; further, bulls with herds, or accompanying herds, tend to wander far along with the herds, and it is the confirmed lone bulls (which are frequently seen by themselves in the same area) that can be observed over a number of years, particularly where they have not been shot at or otherwise seriously disturbed by men. The last condition, however, is so rarely fulfilled that such bulls, especially those owning fine heads, frequently have their lives ended prematurely to provide trophies to hunters. From such records and hearsay reports as are available it seems probable that gaur live to about 30 years at least—a long enough age for the animals to get to know their ranges intimately and to be severely affected by the usurpation of their territory by men.

Among shikaris it was considered that the number of annulations at the base of a gaur's horns provided a reliable indication, not of its age in years, but of its maturity. Neither the blunting of the horn-tips in old bulls nor the number of annulations at the base of the horn can be considered entirely reliable indications of the stage of life reached by a gaur. Undoubtedly there is much truth in the admirable depictions of the development of the horn in gaur provided by Forsyth, and no more dependable indications of age are available when observing the live, wild animal. However, some quite young adult bulls may develop the lateral spread of horn typical of maturity, though their horn-tips still remain sharp (photographs MP 37 and 38 show such a bull, with an almost 'handle-bar' type of horn formation). Some old, really big bulls of both the 'kinds' of gaur detailed may show a similar lateral spread with much-blunted tips (photographs TN 1 and MP 26). Neither can reliance be placed upon the blunting of the horn-tips as some quite old bulls may show one horn or both sharp-tipped (photographs TN 10 and 16). Some very big bulls with exceptionally fine horns may not show the lateral spread so noticeably (photograph TN 48). The mass of the horn seems to be a more reliable indication of maturity, but it is only positive evidence, i.e., a bull with noticeably massive horns is no doubt mature, but a mature or even a quite old bull may not have massive horns. The point need not be laboured further, but I may refer to photographs K 19 and TN 4 and TN 10: the big cow in K 19 had probably finer horns than either of the bulls shown in the other pictures. Annulations are not wholly reliable tokens. In some really old and big bulls, there is hardly any annulation visible at the bases of the horns; perhaps this is due to their having been rubbed smooth, but it seems more likely that the annulations were not deeply formed even originally (photographs TN 1, TN 16 X photographs TN 7 and TN 10). However, it is not as if a fair idea of the stage of life is not provided by observing the horns of a gaur closely, and going by overall judgement rather than by the narrow application of any rule. In fact, this is the only manner in which age can be judged, for illness, injury and other debilitating influences profoundly affect the looks of a gaur.

The consensus of opinion on the perceptions of gaur is that while they have exquisite noses, their vision is not acute and that being noisy in their movements, they depend little on their ear to warn them. Regarding their powers of hearing it is true that when following a herd of gaur it is not necessary to take great pains to tread softly so long as the animals ahead are on the move, the noise of their movements covering the sound of one's footfall, but it is necessary to keep the wind right and not to show oneself openly (K 60 Apr. 14); as against this, I have known a lone bull get alerted by hearing a twig snap sharply under the foot of the riding elephant from more than a furlong away, and to bolt without turning round for visual confirmation of the sound, when he could not possibly have been warned by smell. Further, most of the intraspecific communications of gaur are through sounds, and apart from warnings being conveyed by vocal and nasal sounds, they thump the ground with their forefeet in unison during the first few yards of their getaway, as pointed out by Schaller, evidently to communicate the line of their retreat to other gaur: I should add that the sudden getaway of gaur on hard ground produces a drumming sound made by the hooves on the hard earth, not to be confused with this thumping (B 69 Feb. 3/4 and 5/6). It seems likely that their range of sensibility to sounds is different from ours and they are probably better able to appreciate subtle differences in high-pitched sounds.

Sight is undoubtedly not acute in its ability to pick out a stationary object that is not flagrantly visible. Gaur invariably turn round to stare at something that has roused their suspicions (such as the movements made by a man in cover) when they cannot get olfactory confirmation of their apprehensions; when one gaur does this, the rest may also turn in the direction it is facing, but initially they watch the alerted animal rather than what it is staring at (K 70 May 7).

Their reaction to the sight (unconfirmed by smell) of human beings varies. Nothing alarms them so much, not even the sight of a tiger, as the sight of men on foot, and their normal reaction is to bolt far and fast. Men in an automobile, as with most other animals, scare them less immediately, and occasionally men on elephant back are even accepted, provided they observe certain precautions. The gaur are perfectly aware of the identity of the men atop the elephant, but so long as the latter do nothing that alarms them, they may accept the unnatural combination of elephant and men. Gaur seem somewhat shortsighted, but are well able to make out a mobile man from over 200 yards away.

Smell, of course, is their chief sense. Wind being right, they can smell a man from over a furlong away even through the forest, and will bolt without waiting for visual confirmation: they may also wait for visual confirmation on occasion. The assessment of the perceptions of gaur by observing them is made somewhat difficult by the fact that their overt reactions to things sensed by them is bovine and stolid, and not visibly displayed till the moment of actual, acute response (such as flight). The question whether or not they can follow a ground scent has interested me for years, and I have been unable to ascertain this. When moving through the forest, they do not put down their heads to smell the line taken by other gaur which have gone well ahead of them but, apparently, only to graze or browse.

Gaur smell the oncoming rain, facing the direction from which it is spreading (TN 62 Mar. 19—photograph TN 11); a herd out in open forest splits into parties and the parties seek the shelter of trees with thick, spreading crowns, such as *Schleichera oleosa* and *Bischofia javanica*, huddling beneath it in a compact group till the downpour is over.

Some confusion seems to exist in the records of the sounds made by gaur, but this is due to the fact that animals sounds are often difficult to indicate unmistakably in terms of onomatopoeic phrases, because some measure of personal interpretation is inevitable in such renderings. The point may be illustrated by the diverse, excellent interpretations of bird-calls in familiar phrases common in human languages. The call of *Cuculus micropterus*, for instance, is rendered in English as 'Broken Pekoe', 'Bau kotako' in Bengali and 'Kyphul pukka' in Hindi: all these renderings only serve to indicate that the call has 4 syllables, of which the first and third are probably accented: there is no agreement on vowel sounds and none at all on the consonants, the initial 'k' of the last syllable in all three renderings being fortuitous. In the interpretation of gaur sounds in onomatopoeic terms, the lack of direction or certainty to the consonants and vowels is even more marked in view of no call of the animal being reminiscent of a familiar phrase in any language.

These are the main calls I have heard from gaur. When grazing or browsing in company in a small party, usually when the undershrub is high, they sometimes come out with a low moo, almost or quite indistinguishable from the moo of Indian domestic cattle but lower (B 69 Feb. 22). Evidently this is a call used in keeping in touch, and is hardly audible from 100 feet. Cows also come out with a soft, bronchial grunt, which also has little carrying power.

The snort of surprise or alarm with the head, and usually the tail as well, thrown up and the nostrils flared, is often, but not invariably, the prelude to flight, and on a gaur coming out with this sound the entire herd takes alarm (TN 62 Sep. 14, 64 Sep. 21—photograph TN 63 shows a cow at the moment of coming out with this sound, and also 2 seconds later, placid once more, having got over her surprise at suddenly seeing men atop a stationary elephant). Although this sound is an entirely spontaneous response to alarm, the initial part of it (which perhaps consists in a sharp intake of breath) is muffled, and what follows is an eruptive snort. Dunbar Brander renders this 'pff-hong' and adds 'the "pff" is the noise made by the rush of air past the lips before the note is struck'. To my ears, the sound is definitely both nasal and eruptive, i.e., a snort.

Bulls, and cows even, come out with short, deep bronchial grunts and snorts when excited or angry, as when a tiger or leopard is seen or when surrounded by dogs.

Two calls uttered by bulls, which may be termed the herd call and the love call, are both produced in a similar manner. The herd call is a long-drawn, resonant low, pitched high and at the same time not loud even when heard from quite near, though it has great carrying power and is clearly audible to human ears from half-a-mile away or longer. The call often differs in its pitch from bull to bull, some bulls having a brassy voice reminiscent of the sound of the huge, involute horns blown on formal occasions among certain tribals (B 69 Feb. 3/4 and 5/6; B 69 Feb. 22; MP 70 Mar. 20—photograph MP 38). The mode of production of this call, however, is the same in all bulls. At the start of the call (which begins on a muffled note) the head is held low, and as the call is sounded the head is slowly raised at the stretch of the neck till at the end of the call the muzzle with the lips partly open is pointing up, with the whites of the eyes showing with the effort. I have heard the call, and observed it closely from near, and photographed the bull coming out with the call, on several occasions; it is often sounded by the bulls with a herd (a composite herd) when the herd has been split by chance, as when it breaks up to shelter from a sudden downpour, and then reunites (K 60 Apr. 16; TN 62 Sep. 14, 64 Sep. 22 and 25, 66 Oct. 2—photograph TN 48). The purpose of the call is not clear, though it is clearly a communication to other gaur, usually a communication to the cows in a herd: so far as I have been able to observe, it does not attract the herd towards the calling bull, but it does seem to have the effect of halting the herd, so that till the bull rejoins the herd (as I have watched him doing) it does not wander further away.

Bulls come out with the herd call usually when separated from the herd or other gaur, though sometimes (especially when a sharp downpour has caused the bulls to leave a composite herd temporarily) the herd may be in sight. The call is one of the most evocative of all forest sounds, and has surprising acoustic properties: heard from near it is not loud, but from half-a-mile away it is still clearly audible. On occasion the same call, somewhat shorter in duration and louder, with a brassy edge to it or else a metallic drone accompanying the call, is sounded by bulls approaching a salt-lick or water, evidently as an announcement of their approach (B 69 Feb. 3/4 and 5/6; O 70 Jan. 22).

The same call, pitched louder and with a more resonant and urgent intonation to it, is used as a summons by bulls, apparently a summons in a crisis. A herd of 35 to 40 gaur with 3 big bulls in it had split into 3 parties and was proceeding along a fireline, with two parties keeping to the cleared space and one entering the tree forest across the clearing, when the leading bull came out with this call: immediately, another bull, about a furlong behind, answered the call and came up at a run, followed by the rest of the gaur also coming in at a run. A tiger, lurking in the cover of the forest, had provoked this alarm (TN 64 Mar. 31).

Variations of the herd call, not readily appreciated by the human ear, have intraspecific communication value.

The love call is also made with the head at the stretch of the neck and raised as the call is uttered, with the muzzle pointing up at the conclusion of the call with part-open lips, but does not commence with the head held low as in the herd call: it is also commenced with a hardly audible muffled sound which develops to a high-pitched whistle which vibrates to a lower tone at the end. Dunbar Brander describes the call in these words: ‘ Bulls when breeding, and in the herd for that purpose, utter the most absurd piping or whistling sound, more like the call of a bird than anything else, and absurd by reason of its emanating from so large and powerful an animal.’ There is a measure of discrepancy to the human mind between the huge size and muscular build of the bull and this high-pitched, soft call, but the effort behind it is evident and it is absurd, if at all it seems so to the human mind, not because of this discrepancy but because it is so manifestly a love-call. In all the calls of the gaur bull which are variations of the herd call (the love call may also be construed as such a variation) a striking feature is the effort behind the call and its muted commencement—even in its ending these calls often seem to trail off into silence rather than to end abruptly, and this is why I think they may have an acoustic significance to the different audile perceptions of gaur, not appreciated and probably not even heard by the human ear. The love call is invariably sounded only when the cow in season (or which is about to get into season), which the bull is so ardently and persistently courting, is near him, and it does not carry far—in the circumstances, it does not need to carry far (TN Sep. 14 and 17).

Cows do not respond to the love call or the herd call of the bulls with any vocal expressions. Calves are usually silent; I have heard a calf come out with a call only once, and on that occasion it was a prolonged, nasal, plaintive call, precisely the call of a calf of domesticated Indian cattle, and evidently addressed to its mother.

Besides these calls, the bulls bellow, apparently when angry or excited. Another vocalisation of bulls is a low, moaning and grumbling, varied on occasion with puffing expulsions of breath, indulged in while running (usually while running around in a circle) or walking, in the presence of another bull: this seems a placatory sound addressed to the other and usually larger bull (TN 63 Sep. 27, 64 Mar. 19). A bull approaching another comes out with a series of low, eruptive snorts with the head low: in response to the approach of another bull, a bull may come out with these puffing snorts (varied with hoarse grumbling sounds) while running around and swiping at the bushes with lowered horns—TN 64 Sep. 25.

Attitudes and displays are important expressive means, particularly in intraspecific communications. Horn tossing is perhaps the most important of these, and seems to differ somewhat in its display with different situations. Bulls (both bulls with herds and lone bulls) use this threat display towards riding elephants and men at times. When the demonstration is a prelude to a getaway, the head is lowered to a bush and with quick, violent sideway swipes of the horns the top twigs and leaves of the bush are sent hurtling up into the air, often to a height of 15 to 20 feet (TN 59 Mar. 8, 12, 16, a.m.). At other times, particularly when the demonstration is more aggressive and directed towards the riding elephant, the head is not lowered and no tearing up and flinging up of bushes is indulged in, but the bull takes a few steps forward quickly and tosses its head, held high or level with the back, from side to side in a menacing gesture—incidentally, this gesture is well understood by the riding elephant which, if timid, bolts (TN 59 Apr. 2, 62 Mar. 23, 63 Apr. 5—photograph TN 13). Twice a herd bull was observed covering the retreat of the herd I was following on elephant back, using this intimidatory display towards the riding elephant (TN 59 Mar. 16, p.m.—photograph TN 4—and 70 Sep. 21).

Bulls, and also cows, in a herd use a different threat (sometimes with a literally more pointed communication!), with their horns directed towards other gaur in the herd. The display has two main occasions, when it is intended to drive away some member of the herd whose proximity is resented, and when it is intended to direct a subordinate animal in the lead—the second occasion is dealt with in the note on leadership. When used as a driving-away display, as by one bull towards another (especially when the latter is running with a cow) or by one adult cow towards another cow (cows never use this display against bulls, and bulls do not usually use it towards cows), the head is lowered and the gaur lunges at the animal it wishes to move with its horns : this is usually sufficient to shift the object of hostility a safe distance away, but this display is so sudden that often it is not only a formal gesture, but an actual attack, whether intended as such or not, with the demonstrating animal getting home with its horns on the animal towards which the display is directed, with the natural consequence that the retreat of the latter is even more precipitate than it would have been otherwise. Two bulls in a herd, each running with a cow, were seen using this display towards a third and older bull in the herd (TN 62 Sep. 14) ; the big bull in a herd, no longer running with a cow, was seen repeatedly threatening a young bull with this display (TN 63 Sep. 25). Cows were also seen threatening other cows with it.

The goring of termite mounds is probably mainly a form of redirected aggression, as thrashing bushes is, but perhaps it also serves to scrub the boss between the horns and the hollow beneath it—on two occasions, when a big bull was observed demolishing a termite mound, it was noticed that the boss came into intimate contact with the mound and was rubbed against it (TN 64 Apr. 10 and O 70 Sep. 27). Bulls thrash the bushes frequently with their horns when not running with a cow (TN 63 Sep. 27). Sparring is uncommon in herds where the dominance values have already been established, and was not observed as a prominent feature—in such gregarious associations, the threat display or actual prodding with the horns took the place of sparring.

Schaller attaches much importance to the lateral display, common in most bovines when two adult bulls approach each other, and describes it fully. In this, the demonstrating bull presents his profile to the other, with his back held somewhat hunched and the feet close together: naturally the other bull has to be more or less at right angles to the bull demonstrating for the effectiveness of this display as interpreted, but need not be head-on to it, for gaur have lateral vision and even if the other bull is side-on to the displaying bull, the profile would be seen. But it was noticed that the displaying bull stays put, while the other is moving and often moves at an angle where he can only see the displaying bull end-on: the bull displaying does not reorient himself to present his profile to the other bull. Further, it was noticed that even when the approach of the oncoming bull was oblique, with the bull displaying at an acute angle, the display was staged. All this was noticed in the course of attempts in 1962–64 to photograph the lateral display in the Mudumalai Sanctuary, and the one clear picture taken is not reproduced here as it is too long, in format, but a big print of it is with the Bombay Natural History Society (titled ' No longer on talking terms '): it shows the two bulls both adopting the lateral display and more or less in a line, facing opposite directions, so that they cannot possibly see each other. I should add that this was not a display directed at me on the riding elephant, as the elephant was kept far away and moved in for the picture only after an impasse had been reached in the display of the two bulls. A comparison of photographs TN 39 (which shows a bull adopting this tense, somewhat hump-backed posture with the feet close to one another and the head low) and TN 49 (which shows a bull in profile standing at ease) will indicate the attitude assumed by the displaying bull.

Whatever may be the significance of the lateral display in bison and other wild bovine animals, I do not think that in gaur it has an aggressive intent. It seems to be essentially a non-combative or placatory display, and what is more, for its effective communication it need not be lateral and may well be oblique or even end-on. Schaller also thinks that it obviates actual conflict (the purpose of almost all displays) but while it may, it also may not. The same difficulty arises in interpreting the desultory, formal grazing indulged in by two bulls in the presence of each other as a gesture of subordination : both graze in this manner, and may graze gradually closer to engage in sudden, violent combat (TN 63 Sep. 27—photograph TN 31). A quite extraordinary end to a combat between two bulls belonging to different herds was observed, in which the ‘ chela ’ (subordinate bull) of one of the combatants, a brown bull smaller than either combatant, rushed in with moaning sounds, snorts, and violent horn-tossing, followed by the entire herd of the bull to which the ‘ chela ’ belonged, separating the fighting bulls and sending them back to their herds (TN 63 Sep. 27). Schaller cites the wounds and tattered ears of fully adult (‘ black ’) bulls as evidence of their having indulged in sparring : wounds are received in major fights between bulls, and to judge from the violence and savage, all-out thrust of combatants on such occasions (photograph TN 31) deep-gored wounds might well result in such encounters, but tattered ears are not, generally, the result of fighting. The ears are not exposed to attack in such fights, and it is much more likely they get torn in the passage of the animal through spiky cover. That gaur do enter and move through dense spiky cover is a fact (TN 62 Sep. 20) and on the sides of many animals the marks left by twigs and thorns brushing against them are visible, not as scratches usually but as lines marked on the coat (photograph TN 49).

Licking is, in certain contexts, the most important communicative means employed by gaur. Subordinate bulls (‘ chelas ’) lick and nuzzle the master bull, which may or may not accept the placatory blandishment (TN 63 Sep. 27, 64 Oct. 7). Bulls and cows running together during courtship lick each other. However, the most important function of licking is in the mother-infant relationships of gaur, Newborn calves are literally licked into shape, the long, steady strokes of the tongue of the mother evidently providing a lingual massage supplemented by the chin of the cow also rubbing against the calf during the movements of her head while licking (TN 62 Sep. 14, 63 Mar. 17—photograph TN 22 shows a newborn calf). Cows do not depend upon vocal summons in calling very young calves (though they moo to older calves) but go up to them and lick them to induce the infant to follow them, even when an acute situation where they apprehend danger to their young arises: calves, both when old and when very young, are fascinated by elephants on occasion, and will follow them (TN 63 Sep. 17). On one occasion, when an infant calf came up to a riding elephant which seemed nervous of its approach and directed a spray of spittle from its trunk at the calf, the mother (a young animal—this was possibly her first calf) came close up to the elephant to lick and retrieve her young (TN 64 Apr. 8—photograph TN 36).

There seems to be some confusion over the question of the leadership of a herd or party. In a herd, usually spread out over a considerable extent of forest, it is obviously not possible for any member of the herd to take on the important function of sounding the alarm when danger threatens: any member may snort in alarm, and instantly the entire herd is alerted (TN 62 Sep. 14). In a small party of 6 to 10 gaur, it is much easier to perceive that the leading animal, usually a young cow or bull, is not the leader. I have observed this on many occasions, and it is usually a mature cow (or it may be the big bull of the party) that gives the directions to this leading subadult or young adult: it rushes up and prods it or threatens it with a display of tossed horns, to make it take a definite line and go ahead (TN 63 Apr. 2, 66 Sep. 28). On occasion the big bull of even a large herd may, wishing to turn the herd in a particular direction, come up to the middle of the herd, stop, turn pointedly and lead: he may, while grazing away from the herd, come up to the herd and summon it with a herd call (K 60 Apr. 16) or, more usually, merely by showing himself and then turning back and leading the retreat (K 70 May 4 and 9). The bull usually leads the retreat when a herd is headed away and turns back, because the big bull is usually at the rear end of the moving herd. While grazing, some animals may stand still, chewing the cud on occasion, and obviously these are in a better position to sense any threat than the animals that are grazing, but no regular sentries appear to be posted; similarly, when gaur lie down for their siesta, a few animals may remain standing, and when these lie down, others may get up (TN 62 Sep. 17—photograph TN 18); however, I have seen the entire herd lying down for a long rest, without any animal being on its feet.

When followed, lone bulls and even herd bulls tend to lie down in tall grass, and evidently this is a purely instinctive reaction since very often such grass as there is does not hide them at all (TN 59 Mar. 9—photograph TN 1—59 Mar. 16, 66 Sep. 26—photograph TN 47). In considering their alertness and tendency to lie up in this manner, it should be remembered that on the uneven ground they generally favour gaur are quite fast and surefooted. I once saw an entire herd of 23 animals leap clean across a 10-foot wide nullah, and on slippery ground after rain where the riding elephant (an unusually surefooted beast) found considerable trouble in negotiating the steep slopes, the gaur were moving fast with no difficulty (TN 59 Mar. 15 and 62 Sep. 15 and 16).

The main predators that gaur have to be on their guard against are men, and to a lesser extent tigers, and to a much lesser extent leopards. In a herd they seem to have little to fear from tigers, and do not run away but mass together in a prominent musk-ox formation, with the young in the centre and the bulls and the big cows on the periphery. I noticed this reaction to a tigress that was circling a large herd with several calves in it in the Kargudi area of the Mudumalai Sanctuary late in September 1958, and again in the same area in 1964, though on the latter occasion the tiger was not seen (TN 64 Mar. 31). No doubt tigers occasionally prey upon calves and young gaur, and rarely on full-grown animals (B 69 Feb. 17—photograph B 11). Leopards, apparently, occasionally take young calves, when they can. A small leopard was seen intently watching a herd of gaur in which there were calves, and when the leopard bolted on seeing us, the gaur cows saw it, snorted and rushed towards it at a fast walk with heads low, tossing their horns (TN 62 Apr. 7). On another occasion, the cows similarly rushed snorting at a big leopard which, seeing us on elephant back, was proceeding up a rise which they topped from the opposite side—the leopard vanished into cover with a jump (TN 59 Mar. 25). Men undoubtedly constitute their chief enemy, and gaur are terrified of men on foot. I have walked almost right into a lone bull in tall grass, who being aware of my movements though I had no inkling of his presence, was waiting for me standing up alert: he crashed away when he saw me, from about 6 feet away. I believe that it is seldom or never that gaur attack men when not provoked and when a line of retreat offers. Of course there are records of men having been killed and savagely ground underfoot by gaur bulls which they have wounded and followed up to kill: gaur, like elephants and other large vegetarian animals, do not know when to stop killing when they kill men, and may grind the remains into the earth. However, gaur are probably the most placid and inoffensive animals of their size anywhere in the world, and do not of their own accord attack men. Dunbar Brander points out, very rightly, that gaur cannot be driven, They just walk or run past the men seeking to encircle them. On one occasion, when an attempt was made to encircle a large composite herd of gaur so as to display it to some visitors, in the Mudumalai Sanctuary, the result was that the entire herd left the area at once (TN 62 Sep. 22).

When wounded severely, whether by men or other gaur or predators, gaur seek retreat in cover, and evidently recover from grievous injuries and set-backs. Schaller comments on gaur being specially prone to injuries, most of them incurred in the course of intra-specific fights and accidents. Even not taking into account their great mass and the precipitous terrain they often inhabit, gaur are no more prone to accidental falls than most other animals—chital and sambar, too, are sometimes seen with wounds and other injuries. In fights between bulls, great care is taken not to expose a flank to the adversary, the fights being generally a head-on clashing of horns with the entire thrust of the body behind the horns (photograph TN 31); however, when the defeated bull turns to flee, he has to expose his flank and hindquarters, and the victor may and does at times get in a quick jab—this happens among chital also and there is no instinct inhibiting such attacks by the defeated bull exposing itself to attack. Injuries to the hock, resulting in permanent lameness, may be caused by a tiger attempting to hamstring an adult gaur: I have personally known a tiger seeking to immobilise a big domestic cow buffalo by biting her in the hock, before the buffeting horns drove him away. During the survey period several hundred different gaur were seen, and only a few carried major wounds or other injuries; an old lone bull lame in the hind leg (TN 62 Mar. 18), an old lone bull with deep, long flesh-wounds suggesting injury from the claws of a tiger (TN 63 Mar. 21), a big cow with what looked like gunshot wounds high up the shoulder (TN 63 Mar. 25), a big bull with bloody, gored wounds accompanied by a 'chela' (TN 64 Oct. 7) and an old limping cow (B 68 Apr. 28).

The night vision of gaur seems fair. Approaching an artificial salt-lick in the Kanha National Park at night, near which men in a stationary jeep were keeping very still, they spotted the men from about 200 feet away by moonlight and approached in a series of jerky advances, irresistibly bringing to mind the movies of the old 'silent days' when the projector was behaving in an erratic manner (MP 70 Mar. 17—photographs MP 34 and MP 35).

An important aspect of the night behaviour of gaur at the Kanha National Park (important because of its general application to most animals in areas where they are much disturbed by day and stay in cover during the daytime, though normally diurnal) is that at night they are much less apprehensive of men than by day (MP 70 Mar. 5—photograph MP 26).

In a herd, the calves generally keep more or less together (as do their mothers), either in the middle of the herd or, occasionally, in the vanguard (TN 63 Sep. 17). Generally each cow has only one calf running with her and one calf at a birth is the rule, but occasionally I saw two young calves running with a cow, once after an interval of days (TN 62 Sep. 17 and 22, 64 Mar. 31).

The big bull (or bulls in a composite herd) may be anywhere in the herd, or near it, but when the herd is on the move, it is usually in the rear.

The question of herd composition is complicated by the free-ranging habits and longevity of the animals, and by their familiarity with their stamping grounds which makes it possible for them to move in detachments rather than in a tight herd. The only way to determine the question is to follow a herd through all its wanderings and vicissitudes for at least 2 years, keeping a daily record of observation, though the observation need not be from near. My own attempts at securing some photographic evidence of the same gaur at the Theppakkadu area of the Mudumalai Sanctuary during consecutive years in September-October (when the composite herds usually arrive at the natural teak forests), based on observation of the gaur here in 1962, 63 and 64, were frustrated by the work being interrupted in 1965, and by the rinderpest epidemic that drove the gaur (the survivors) out of the area in 1968 and 1969—even in 1970, only a few gaur were found here.

It is not claimed that on the basis of my observation notes and photographs I can conclusively prove what follows, but neither can any of the others who have advanced opinions on the point prove their views. As already said, the only way to secure positive proof is to follow a herd over a period of years.

Unlike chital, and like elephants, gaur seem fairly stable in their herd composition. Some confusion has arisen over the issue by not allowing for the herd never being a rigid, immutable unit of numbers seen constantly in association—by such a test, the concept of a family among ourselves cannot be sustained. Herd composition is further complicated by two diametrically opposed tendencies. When moving to fresh feeding grounds as seasonal variations and needs may dictate, two or more herds may keep together for the time being, forming a composite herd in which the structure is necessarily unstable. The reverse position also obtains : a herd shifting to new grounds may break up into small parties and it is only at the ultimate destination that these parties may reassemble into the herd again (TN 64 Mar. 17, p.m., 66 Sep. 24, a.m.). In some places, as in the Kanha meadows, when the herds move in in this manner, there may be loose, shifting associations between the parties belonging to different herds for a period before each herd settles down. This tendency of the herd to split into parties may also be noticed when it is foraging by day (in areas where gaur feed by day, as is their natural habit); the big bull, and other adult or near-adult bulls in the herd, may keep well away from the herd till nightfall, and even the cows may split into a number of parties which may be at some distance from one another. This may be observed in the Periyar Sanctuary, where there is a large herd in and around Aiyappan Kurukku: photographs K 31, K 32, K 33 and K 34.

However, the same animals are to be seen in association in the same place at intervals of several days (TN 59 Mar. 26 and 31, 62 Sep. 14, 15, 16 and 17, 63 Sep. 13, 15, 16 and 22, and 25 and 27, 64 Sep. 22, 23 and 25). Further, the same animals may be seen in composite herds in the same area during successive years.

Sanderson and his contemporaries assumed that lone bulls among gaur were the master bulls of herds which had been ousted by younger and stronger rivals when past their prime. Dunbar Brander thought that herd bulls lost their interest in the cows comparatively early in their lives, and thereafter preferred to stay by themselves as lone bulls—this does not explain the existence of young solitary bulls which, so far as is known, also stay away from herds. Dunbar Brander and, following him others, thought that the master bulls of herds associated with the cows only during the breeding season—this, after realising that in gaur there was no defined breeding season.

Broadly speaking, gaur are polygamous: all that is meant by the term here is that the bull in the course of breeding associates with several cows in the herd, as they come into season: such polygamy does not preclude the existence of a matriarchal hierarchy among the cows. Normally only one master bull is to be found in a herd, though occasionally there may be two, one being definitely the larger and more dominant: in a composite herd, on the other hand, there are invariably more than one fully developed bull, usually from 2 to 5, depending on the size of the herd. Further, each of the bulls in a composite herd may be running with a cow in season or about to come into season—such bull-cow pairs generally keep a little to one side of the herd, and do not get into one another's way. In addition to these fully developed bulls, there may be one or more near-adult brown bulls. But the one constant feature of any sizeable herd, single or composite, is that invariably there are many more cows than bulls among the adults, while the sex-ratio is probably equal among subadults and calves. This is why a herd may be termed polygamous even if, as some seem to think, the entry of bulls into the herd when a cow is in season is promiscuous. I have never seen more than 2 adult bulls in a herd of about 20 animals, whereas nearly 60% of such a herd is made up of adult cows, which usually outnumber the bulls, calves and subadults put together. I give below the sex counts for some herds, chosen at random from the field notes:

TN 59 Mar. 26: 33 gaur. 2 fully developed bulls, one near-adult bull, 4 subadults of undetermined sex, 5 calves, 21 adult cows.

TN 62 Sep. 14: 40 gaur, composite herd, 3 fully developed bulls, 2 near-adult bulls, 4 subadults of undetermined sex and 4 old calves and 2 young calves, 25 adult cows.

TN 62 Sep. 17: 35 gaur, of the larger brown 'kind', a composite herd. 3 fully developed bulls of which two were old, 3 young bulls, 6 subadults of undetermined sex and 4 half-grown calves and 3 young calves, 16 adult cows (photograph TN 19).

TN 63 Mar. 12: 9 gaur. No adult bull, 3 subadults with 3-inch spike horns, one calf about 6 months, 5 adult cows.

TN 63 Sep. 17: 33 gaur of the larger brown 'kind' in a composite herd. 3 fully developed bulls, 1 near-adult bull, 4 calves and 4 subadults of undetermined sex, 21 adult cows.

TN 66 Apr. 20: 23 gaur in a single herd, of the smaller 'black' kind. 2 fully developed bulls, 1 near-adult bull, 2 calves and 6 subadults of indeterminate sex, 12 adult cows.

K 70 May 7: 38 gaur in a localised herd. 2 fully developed bulls, 1 smaller brown-black bull, 5 subadults and 3 calves of undetermined sex, 27 adult cows (photograph K 31).

B 69 Feb. 3/4: 7 gaur at the Ligirda lick in a party. 1 adult bull, 1 subadult bull, 2 subadult cows, 1 half-grown calf, 2 adult cows.

MP 70 Mar. 17: 16 gaur at the Sravantal lick. 1 adult bull, 2 calves, 2 or 3 subadults, 10 adult cows.

The total number of gaur in the above random samplings from the notes comes to 234, and the adult cows in these herds and parties to 139, representing a percentage of 59 of the total population—naturally, lone bulls have been left out of this reckoning as also herds seen without any bulls in them. The number of cows identifiable as such in 20 photographs (only 2 of which are reproduced here, i.e., TN 20 and K 31) which are representative pictures of herds, was counted and the percentage of cows to all animals in the herds again came to 60. These figures will go to show to what exent adult cows predominate in a herd.

Schaller and a few others have written about the 'rutting bull'. I am unable to comprehend the connotation of the term. In gaur, as among all cattle, it is the cow's coming into season that determines mating. The sexual act, as in all bovines, is completed in a few seconds but the courtship extends over days. The rut may be strictly defined as sexual excitement in the male of any species, and if the suggestion in terms such as 'rutting bull' and 'rutting season' is that there is a seasonal abundance of virility and increased sexual desire in gaur bulls that conditions breeding, the suggestion is entirely unwarranted. It is solely the cows getting into season that determines breeding, and there is no seasonal periodicity in this: as in domestic cattle, gaur cows in a herd come into season at different times, each cow having her own œstral cycle.

The field notes provide the probable age of calves seen, classifying them into very young (definitely under 2 or 3 weeks old) and older (from 1 to 6 months) calves. Ignoring the estimated age of the older calves, and taking into account only the newborn calves and calves definitely under 2 weeks of age, and assuming that the period of gestation in gaur is 9 months (this is near enough), analysis of a few records of calves seen provides the following information regarding their conception:

TN 59 Mar. 26 : 1 golden sienna calf, about 1 week old, in a herd of 23 ; must have been conceived mid-June.

K 60 Apr. 14 : 1 golden sienna calf under 2 weeks, along with older calves, in a herd of 16 ; must have been conceived early July. Photograph K 7.

TN 62 Sep. 14 : Newborn calf, about an hour old, being licked by its mother ; must have been conceived mid-December.

TN 63 Mar. 17 : Newborn calf, less than an hour old. Must have been conceived mid-June. Photograph TN 22.

TN 64 Mar. 23 : 3 very young (under 2 weeks) golden brown calves in a herd of 19 ; must have been conceived about mid-June.

TN 66 Sep. 30 : Cow with newborn calf; must have been conceived end of December.

MP 70 Mar. 15 : 1 calf about 1 week in party of 16 ; conceived mid-June.

TN 70 Sep. 15 : 1 calf under 2 weeks in a herd of 15 ; conceived early December.

At first sight this may suggest that there are two main breeding periods, in June-July and in December-January. Such a conclusion is entirely unwarranted and fallacious : it ignores two very relevant facts, i.e., that all these observations were made in March-April and in September, and more important, that there were older calves, from 3 to 6 months old seen with the herds in which these young calves were seen. A few random selections from the field notes will establish this, and it is important to note that even if the estimates of the ages of the calves observed are out by a month or two either way (though I do not think they were) it makes little difference, for once the fact is established that calves of from 3 to 6 months were also seen in March-April and September-October, the extension of the ‘breeding period’ by several months is also established.

TN 62 Mar. 24 : 3 calves of from 4 to 6 months ; conceived late February to late December. Photograph TN 15 shows a 4 months' old calf.

K 60 Apr. 14 : 3 calves from 4 to 8 months ; conceived March to December. Photograph K 7.

TN 66 Apr. 20 : 1 very young calf and 1 calf about 3 months ; conceived July and April.

It will now be seen that the 'breeding season' extends from February to July and from December to January ; i.e., only the months of August, September, October and November are left uncovered by the evidence so far adduced. Gravid cows were also seen on occasion (for instance a heavily gravid cow seen TN 62 Mar. 24 and a gravid cow seen TN 62 Sep. 14) but less speculative evidence is available. A few records from the field notes of bulls actively courting cows in season (or about to come into season) and attempting to mount them will provide this evidence : apart from the bulls nuzzling the cows and resting their chins on the rumps of the cows they were running with, love calls and the smelling of the genitals and urine of cows with retracted lips and the head held pointing upwards at the stretch of the neck (*flehmen*) are taken as additional evidence of the 'breeding season'.

TN 62 Mar. 24 : A single adult bull in a herd of 21 courting a cow, following her assiduously ; attempted to mount her ; smelt her urine with curled lips and head held pointed up ; nuzzled her rump.

TN 62 Sep. 14 : Sep. 15 & Sep. 17 2 dominant bulls in a herd of 40, containing another older bull and a near-adult brown bull, both kept away from the proximity of the 2 dominant bulls. Younger of the 2 dominant bulls courting a mature cow and the older a young cow. Both bulls came out with the love call, smelt the cow-urine and rested their muzzle on the rumps of the cows. The bull with the older cow tried to mount her several times but she would not stand to him.

In September I saw a cow attempting to mount another, a sure sign that the former was coming into season (TN 64 Sep. 24 : I have a photograph in proof). Another record of a bull courting a cow in September is provided by TN 63 Sep. 22. From all this it is seen that gaur breed all through the year, and that only for the months of August, October and November is no evidence of their breeding available. This is so because during these 3 months I did not observe any gaur anywhere intensively. But even conceding, hypothetically, that gaur do not breed in October and November, that surely does not warrant the use of the term 'breeding season' and 'peak breeding season' and the term 'rut'. The fact is there is no defined breeding season in gaur, that they breed all the year round, and that any increased breeding activity noticed is consequent on more cows coming into season, an event that may be conditioned by so many factors that it cannot be linked up with the calendar.

The next thing to consider is the statement made by Dunbar Brander and others that during the 'breeding season' bulls come into the herds to breed. My experience is that the associations of big bulls with herds is not promiscuous or a matter of chance and seizure of opportunity. The big bulls belong to the herds, and they may be grazing away from the herd for the time being and then come back into it (whether or not the cows in the herd are in season)—some actual instances of the return of the bulls to a composite herd are available in the field notes : TN 63 Sep. 27, 64 Mar. 23, Sep. 22 and 25, 66 Sep. 28 and Oct. 2.

Bulls in a herd do not passively accept the presence of another bull when they are running with a cow, or when they are in the herd but no cow is in season—TN 62 Sep. 14, 63 Sep. 25, 66 Apr. 20.

The question of lone bulls may be taken up now. In areas specially favoured by gaur, such as the north-eastern slopes of the Nilgiris constituting the Mudumalai and Bandipur sanctuaries, lone bulls may be seen of varying ages. All are adult, but some are young adults and some old, or very old. Whether they have left the herd in which they were born and reared voluntarily or not, they do not seem to associate with herds. Considering the hostility shown by the master bulls in herds towards the near-adult bulls, it seems likely that the younger lone bulls are animals that have walked out of the herd to escape being harried by older, bigger herd bulls: if that were so, they would probably get into a herd if they could. The old lone bulls never rejoin a herd, but are truly solitary, though at times they may keep company with another big lone bull. Associations between young lone bulls are not unknown. To give a fair idea of the common occurrence of lone bulls in areas favoured by gaur (since it seems as many male as female young are born, to balance the predominance of adult cows in herds there must be many lone bulls). I give the total number of lone bulls seen during the survey period, and the number of herds and parties seen: no doubt some of the lone bulls were seen twice, thrice and one even four times over, but so were the herds, and such repetition in counting being common to both and not of any appreciable frequency, the two counts may be taken as representing a fair proportion of lone bulls to herds. In all lone bulls were seen on 52 occasions and gaur in herds or parties on 114 occasions. Considering that every lone bull seen represents only one male, and the 50 to 60% ratio of adult cows in herds represents several hundreds seen, there is no counter-balancing evident.

The incidence of cattle-borne epidemics among gaur and the way these affect their survival and distribution may be briefly set out. Sanderson, Dunbar Brander and others write of rinderpest accounting for the entire population of gaur in certain localities. Rinderpest seriously affected the gaur in Karwar in June 1944, and about August 1968 took heavy toll of the gaur in the Mudumalai and Bandipur sanctuaries, perhaps the finest stamping ground of gaur anywhere in their distribution in S. E. Asia. Actual figures of the corpses recovered in both sanctuaries are not available, but it may reasonably be assumed that from 300 to 500 animals of all ages died. A remarkable feature of the epidemic, as I heard it reported from those who had actually seen the afflicted gaur in the Bandipur sanctuary, was that when an animal in a herd was stricken it left the herd and sought cover, and the rest panicked and bolted to areas around, even to areas to which they normally do not go. In September-October 1970, fully 2 years after the' disaster, the gaur were returning to these sanctuaries in small numbers. This infection was traced definitely to the decrepit cattle being herded through the two sanctuaries to slaughter-houses. In 1966 I saw the corpses of gaur that had, apparently, died of some epidemic in the Mudumalai area of the Mudumalai sanctuary (TN 66 Apr. 15 and 16); foot-and-mouth disease had spread from cattle to sambar and gaur in that year in the sanctuary, and I saw an old bull badly stricken by the infection (TN 66 Apr. 27).

THE WILD BUFFALO

Bubalus bubalis (Linnaeus)

(Summary of field notes : Observation records outside Assam limited to tracks and dung seen at Balimela in Orissa and in the Bastar area of Madhya Pradesh. *Photograph* : MISC 4-A).

The wild buffalo appears to be indigenous almost exclusively, having originated in India and Nepal. Formerly, when it had a far wider range in India than now, it was found in the riverain tracts of north-east India, from the Godavari upwards.

Most strains of domesticated buffaloes are derived directly from the wild buffalo, which they closely resemble except for being smaller-sized and less aggressively wild in varying degrees; those domesticated strains living in a semi-feral condition (as in Bokkapura, in the Nilgiris) are noticeably larger and fiercer than ordinary village buffaloes. When truly feral, they regain much of the size and wild spirit of their wild ancestor.

The buffalo was domesticated and highly valued for its milk from quite ancient times, and introduced into countries as far as China and Japan to the east and Italy to the west. F. E. Zeuner (A HISTORY OF DOMESTICATED ANIMALS) provides a succinct account of the early domestication of the Indian wild buffalo and its export abroad. The earliest extant Tamil poetry (approximately 19 centuries old today) contains references to domesticated milch buffaloes and the high regard in which they were held, but does not mention the wild buffalo, though it mentions the gaur. There is no authentic account of the wild buffalo in South India within historic times.

In recent times, the Indian domesticated buffalo, exported to Australia, has run wild in that country, and there is reason to think the wild buffalo of Ceylon feral and not truly wild.

Size : Morphological characters

Prater gives the size of a large bull at from 5-foot 6-inch at the shoulders to 6-foot 6-inch exceptionally: the later figure seems improbably tall, for the buffalo is an exceptionally massive animal, probably broader across the body than any other Indian mammal in proportion to its height, and inclined to be squat rather than tall when very massive. The weight has been estimated at around a ton, for a big bull.

The Indian wild buffalo is the heaviest and most massive of all wild oxen, and probably the fiercest when truly wild. The horns are characteristically flattened on top and rugose, and somewhat triangular in section ; there are two main types of horns, one with the horns semicircular and curving upwards from the head with the tips fairly close to each other (photograph MISC 4-A) and the other type with the horns sweeping out from the head sideways with a shallow curve. Both types of horn may be found in the same herd, as also intermediate types.

Distribution

At present found, within Indian limits, mainly in Assam: a few animals are to be found around the Chitrakunda project, both in Orissa and on the Andhra side of the project, and their fate after the commissioning of the project is unpredictable. A small population is to be found along the river Indravati, in Bastar in Madhya Pradesh.

J. C. Daniel conducted a survey of the buffaloes in the Bastar area early in the sixties. Visiting the areas he went to and a few around in March 1971, towards the end of the month, I found the forest ponds (*tal*) dried up, and only old footprints and dung pats ; I was told the buffaloes had been there, but had moved on, and was shown a *tal* at which a bull had been shot on licence the previous year, though the animals are said to be protected. At Balimela in Orissa (around the Chitrakunda Project) I saw fresh slots and dung of small parties, but not the buffaloes themselves, in January 1969.

Habits : Behaviour

Since no wild buffaloes were observed except in Assam (outside the territory of the survey) no notes on habits are provided. However, a threat display staged by the bull of a small herd in the Mihimukh area of the Kaziranga Sanctuary, may be mentioned (MISC 68, Feb. 3). When approached on elephant back, this bull came trotting towards us till about 40 yards away, and then took a bound forward, stopping with a rocking halt by braking the momentum of the bound with braced forefeet: he then returned to the herd, but staged a similar display awhile later.

(*to be continued*)

A Contribution to the Flora of Gangolihat Block in Pithoragarh District

BY

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[*Continued from Vol.* **68** (3) : 790]

CAMPANULACEAE

Campanula colorata Wall. ex Roxb.
Herb with pale lilac flowers. Gangolihat, 2000 m (423).

ERICACEAE

Lyonia ovalifolia (Wall.) Drude (Loc. Yaanr).
Small tree with white flowers. Daula hill, 2000 m (5146).

Rhododendron arboreum Smith (Loc. Kafoo, Buronj).
Small tree with red flowers. Daula hill, 2000 m (5066).

PRIMULACEAE

Androsace umbellata (Lour.) Merr.
Herb with pink flowers. Mallagarkha, 1660 m (5058).

A. rotundifolia Hard.
Herb with deep pink flowers. Daula hill, 2230 m (5161).

Lysamachia lobelioides Wall.
Herb with pale purple flowers. Mallagarkha, 1660 m (5156).

Anagallis arvensis L.
Herb with bright blue flowers. Mallagarkha, 1660 m (5062).

MYRSINACEAE

Myrsine africana L. (Loc. Karyont)
Small shrub with dark red flowers. Daula hill, 2230 m (5126).

SAPOTACEAE

Diploknema butyracea (Roxb.) H. J. Lamb (Loc. Ghayus)

Large deciduous tree with cream-coloured flowers. Mallagarkha, 1660 m (5128).

OLEACEAE

Jasminum dispermum Wall.

Climbing shrub with fragrant white flowers. Gangolihat, 2000 m (5434).

J. grandiflorum L.

Climbing shrub with white flowers. Mallagarkha, 2000 m (5365).

Osmanthus fragans Lour. (Loc. Shilang)

Evergreen tree with very fragrant pale yellow flowers (planted). Daula hill, 2200 m (5374).

APOCYNACEAE

Carissa spinarum DC.

Spinous shrub with white flowers. Mallagarkha, 1660 m (5077).

Nerium indicum Mill. (Loc. Kaner)

Shrub with fragrant pink flowers (planted). Gangolihat, 2000 m (5227).

GENTIANACEAE

Gentiana argentea Royle

Herb with blue flowers. Nandan hill, 2330 m (5087).

G. capitata Buch.-Ham.

Herb with blue flowers. Goptari, 2000 m (5455).

Swertia paniculata Wall.

Herb with white flowers having purple blotches at the base. Mallagarkha, 1660 m (5387).

S. alata Royle

Herb with greenish-yellow flowers. Gangolihat, 2000 m (5440).

S. angustifolia Buch.-Ham.

Herb with white flowers having purple dots. Mallagarkha, 1660 m (5323).

BORAGINACEAE

Cynoglossum zeylanicum (Wall.) Thunb.

Herb with pale blue flowers. Gangolihat, 2000 m (5293).

CONVOLVULACEAE

Ipomoea nil (L.) Roth

Climbing herb with pale blue flowers. Gangolihat, 2000 m (5338).

I. purpurea Roth

Climbing herb with pink flowers. Mallagarkha, 1660 m (5364).

Evolvulus nummularius L.

Creeping herb with white flowers. Mallagarkha, 1660 m (5398).

Cuscuta reflexa Roxb. (Loc. Amar bale)

Leafless parasitic herb with white flowers. Gangolihat, 2000 m (5359).

SOLANACEAE

Solanum nigrum L.

Herb with white flowers. Mallagarkha, 1660 m (5289).

S. indicum L.

Herb with blue flowers. Pali, 1200 m (5171).

S. surattense Burm. f.

Prickly herb with blue flowers. Mallagarkha, 1600 m (5173).

Physalis minima L. (Loc. Nununi)

Herb with yellow flowers. Mallagarkha, 1660 m (5294).

Nicandra physaloides Gaertn.

Herb with pale purple flowers. Gangolihat, 2000 m (5348).

Datura stramonium L. (Loc. Dhatura)

Herb with white flowers. Gangolihat, 2000 m (5346).

D. suaveolens H. B. & K. ex Willd.

Herb with white flowers. Gangolihat, 2000 m (5193).

Cestrum nocturnum L. (Loc. Rat-ki-Rani)

Shrub with greenish-yellow flowers (planted). Gangolihat, 2000 m (5238).

SCROPHULARIACEAE

Verbascum thapsus L.

Pubescent herb with yellow flowers. Goptari, 2000 m (5102).

Antirrhinum orontium L.

Herb with pale pink flowers. Mallagarkha, 1660 m (5013).

Scrophularia himalensis Royle

Herb with greenish-purple flowers. Gangolihat, 2000 m (5413).

Mazus pumilus (Burm. f.) Steenis

Herb with pale blue or white flowers. Mallagarkha, 1660 m (5011).

Lindenbergia grandiflora Benth.

Rambling herb with bright yellow flowers. Daula hill, 2230 m (5383).

L. indica (L.) O. Kuntze

Herb with yellow flowers. Mallagarkha, 1660 m (5254).

Torenia cordifolia Roxb.

Herb with bluish-purple flowers. Goptari, 2000 m (5274).

Lindernia crustacea (L.) F. V. Muell.

Herb with pale purple flowers. Gangolihat, 2000 m (5431).

L. nummularifolia (D. Don) Wettst.

Herb with purple-red flowers. Gangolihat, 2000 m (5445).

Veronica anagallis-aquatica L.

Succulent herb with white flowers. Mallagarkha, 1660 m (5052).

Striga lutea Lour.

Herb with violet flowers. Goptari, 2000 m (5453).

Pedicularis carnosa Wall.

Herb with purple-pink flowers. Daula hill, 2000 m (5283).

OROBANCHACEAE

Orobanche epithymum DC.

Herb with reddish-brown flowers. Mallagarkha, 1660 m (5054).

GESNERACEAE

Rhynchoglossum obliquum Blume

Succulent herb with white flowers. Gangolihat, 2000 m (5363).

BIGNONIACEAE

Tecomaria capensis (Thunb.) Spach.

Scandent shrub with orange-red flowers (planted). Gangolihat, 2000 m (5165).

PEDALIACEAE

Sesamum indicum DC. (Loc. Til)

Herb with purple-pink flowers. Gangolihat, 2000 m (5299).

ACANTHACEAE

Pseudaechmanthera glutinosa (Nees) Brem.

Shrub with pale blue flowers. Mallagarkha, 1660 m (5034).

Goldfussia dalhousiana Nees

Shrub with dark blue flowers. Daula hill, 2230 m (5279).

Barleria cristata L.

Herb with lilac flowers. Daula hill, 2230 m (5100).

Justicia diffusa Willd.

Herb with pink flowers. Mallagarkha, 1660 m (5266).

Adhatoda vasica Nees (Loc. Basing)

Evergreen shrub with white flowers. Mallagarkha, 1660 m (5070).

Rungia pectinata (L.) Nees

Herb with bluish-white flowers. Mallagarkha, 1660 m (5324).

Dicliptera bupleuroides Nees

Herb with pink flowers. Mallagarkha, 1660 m (5045).

VERBENACEAE

Lantana indica Roxb.

Shrub with yellow or orange flowers. Mallagarkha, 1660 m (5197).

Clerodendrum japonicum (Thunb.) Sweet

Shrub with purplish-white flowers. Gangolihat, 2000 m (5218).

Caryopteris wallichiana Schauer

Shrub with bluish-white flowers. Bhruntam hill, 2660 m (5159).

LABIATAE (LAMIACEAE)

Plectranthus gerardianus Benth.

Undershrub with purplish-white flowers. Daula hill, 2230 m (5377).

P. striatus Benth.

Herb with white flowers. Gangolihat, 2000 m (5285).

P. japonicus (Burm. f.) Koidz

Undershrub with lavender-blue flowers. Gangolihat, 2000 m (5433).

P. mollis (Ait.) Spreng.

Herb with pale lavender-blue flowers. Mallagarkha, 1660 m (5349).

Pogostemon benghalensis (Burm. f.) O. Ktze.

Aromatic shrub with pinkish-white flowers. Mallagarkha, 1660 m (5288).

Colebrookea oppositifolia Sm.

Tomentose shrub with white flowers. Mallagarkha, 1660 m (5071).

Elsholtzia flava Benth.

Herb with white flowers. Gangolihat, 2000 m (5352).

E. fruticosa (D. Don) Rehder

Shrub with white flowers. Bhuvaneshwar, 2300 m (5397).

E. stachyodia (Link) Raiz. & Sax.

Herb with white flowers. Gangolihat, 2000 m (5395).

E. strobilifera Benth.

Herb with pale purple flowers. Gangolihat, 2000 m (5412).

Perilla frutescens (L.) Britt. (Loc. Bhaungir)

Aromatic herb with white flowers. Mallagarkha, 1660 m (5457).

Mentha spicata L. (Loc. Pudina)

Herb with lilac flowers. Mallagarkha, 1660 m (5308).

Origanum vulgare L.

Herb with pink flowers. Gangolihat, 2000 m (5357).

Micromeria biflora Benth.

Herb with pink flowers. Nandan hill, 2330 m (5007).

Calamintha umbrosa Benth.

Herb with lilac flowers. Mallagarkha, 1660 m (5001).

Salvia leucantha Cav.

Undershrub with white flowers. Gangolihat, 2000 m (5302).

Nepeta leucophylla Benth.

Herb with lilac flowers. Mallagarkha, 1660 m (5039).

Scutellaria prostrata Jacq.

Herb with pale purple flowers. Mallagarkha, 1660 m (5051).

S. discolor Colebr.

Herb with pale purple flowers. Gangolihat, 2000 m (5300).

Craniotome versicolor Reich.

Herb with pink flowers. Gangolihat, 2000 m (5450).

Stachys sericea Wall.

Herb with pink flowers. Jeebal, 2000 m (5116).

Lamium amplexicaule L.

Herb with purplish-red flowers. Mallagarkha, 1660 m (5027).

Roylea calycina (Roxb.) Briq.

Herb with pinkish-white flowers. Daula hill, 2230 m (5028).

Leucas lanata Benth.

Woolly herb with white flowers. Mallagarkha, 1660 m (5249).

L. cephalotes Spreng.

Herb with white flowers. Mallagarkha, 1660 m (5214).

Teucrium quadrifarium Buch.-Ham.

Herb with pink or purple flowers. Goptari, 2200 m (5422).

Ajuga bracteosa Wall.

Herb with pale blue flowers. Mallagarkha, 1660 m (5032).

A. parviflora Benth.

Herb with bluish flowers. Mallagarkha, 1660 m (5003).

PLANTAGINACEAE

Plantago tibetica Hk. f. & Thoms.

Stemless herb with green flowers. Mallagarkha, 1660 m (5113).

NYCTAGINACEAE

Mirabilis jalapa L. (Loc. Bhooyi)

Herb with white, yellow or crimson flowers (naturalized). Mallagarkha, 1660 m (5359).

AMARANTHACEAE

Amaranthus spinosus L.

Spiny herb with yellow-green flowers. Mallagarkha, 1660 m (5340).

A. hybridus L. subsp. **cruentus** Thell. var. **paniculatus** Thell. (Loc. Chu).

Herb with reddish-green flowers. Goptari, 2000 m (5317).

Cyathula tomentosa Moq.

Straggling undershrub with shining white flowers. Mallagarkha, 1660 m (5320).

Achyranthes bidentata Blume

Straggling undershrub with dull-green flowers. Mallagarkha, 1660 m (5280).

Alternanthera sessilis (L.) DC.

Prostrate herb with shining white flowers. Mallagarkha, 1660 m (5318).

Gomphrena celosioides Mart.

Herb with white flowers. Pali, 1400 m (5219).

CHENOPODIACEAE

Chenopodium album L. (Loc. Bathua)

Herb with green flowers. Mallagarkha, 1660 m (5080).

C. ambrosioides L.

Aromatic herb with green flowers. Gangolihat, 2000 m (5344).

POLYGONACEAE

Polygonum plebejum R.Br.

Prostrate herb with pale pink flowers. Mallagarkha, 1660 m (5134).

P. hydropiper L. subsp. **microcarpum** Danser var. **lenticularis** Danser

Herb with pink flowers. Mallagarkha, 1660 m (5016).

P. nepalense Meissn.

Herb with pinkish flowers in globose heads. Goptari, 2000 m (5006).

Fagopyrum cymosum Meissn. (Loc. Jangli Ugai)

Herb with pinkish-white flowers. Gangolihat, 2000 m (5209).

Rumex nepalensis Spreng.

Herb with greenish flowers. Mallagarkha, 1660 m (5250).

R. hastatus Don

Herb with pink flowers. Mallagarkha, 1700 m (5037).

PIPERACEAE

Peperomia reflexa A.Dietr.

Succulent herb with green flowers. Nandan hill, 2330 m (5068).

LAURACEAE

Cinnamomum tamala Nees & Eberm. (Loc. Keepari)

Evergreen tree with white flowers. Nandan hill, 2000 m (5107).

LORANTHACEAE

Taxillus vestitus (Wall.) Danser (Loc. Vana)

Semiparasitic shrub with brown tomentose flowers. Goptari, 2000 m (5175).

Korthalsella opuntia (Thunb.) Merr.

A green leafless plant forming nearly erect tufts on *Quercus incana.* Goptari, 2230 m (5336).

Viscum nepalense Spreng.

A green leafless plant forming pendulous tufts on *Quercus incana.* Bhrugtam hill, 2660 m (5174).

V. album L.

A yellow green, erect, tufted, leafy parasitic plant on *Quercus incana.* Gangolihat, 2000 m (5405).

SANTALACEAE

Osyris wightiana Wall. ex Wight

Small evergreen tree with yellow flowers. Bhuvaneshwar, 2300 m (5065, 5385).

EUPHORBIACEAE

Euphorbia hypericifolia L.

Herb with minute involucres. Bhrugtam hill, 2660 m (5291).

E. royleana Boiss. (Loc. Shyun)

Cactus-like shrub with yellow involucres. Mallagarkha, 1660 m (5386).

E. helioscopia L.

Herb with 4-toothed yellow involucres. Mallagarkha, 1660 m (5099).

E. hirta L.

Herb with pinkish-green involucres. Mallagarkha, 1660 m (5255).

E. geniculata. Muell.-Orteg.

Herb with yellowish-green involucres. Mallagarkha, 1660 m (5239).

Emblica officinalis Gaertn. (Loc. Aoula)

Small tree with yellowish-green flowers (cultivated). Gangolihat, 2000 m (5097).

Phyllanthus urinaria L.

Herb with yellowish-green flowers. Mallagarkha, 1660 m (5275).

P. parvifolius Buch.-Ham.

Half-prostrate shrub with purple-brown flowers. Gangolihat, 2000 m (5356).

Ricinus communis L.

Tall shrub with green flowers. Mallagarkha, 1700 m (5328).

Acalypha brachystachya Hornem.

Straggling herb with pale green flowers. Mallagarkha, 1660 m (5298).

Sapium insigne Trimen (Loc. Khini)

Small tree with yellow flowers. Mallagarkha, 1660 m (5120).

Excoecaria acerifolia F. Diedr.

Tree with yellow flowers. Gangolihat, 2000 m (5353).

CANNABINACEAE

Cannabis sativa L. (Loc. Bhang)

Tall herb with pale yellow flowers. Mallagarkha, 1700 m (5050, 5061).

URTICACEAE

Urtica parviflora Roxb. (Loc. Sin)

Stinging herb with green flowers. Mallagarkha, 1660 m (5341).

Girardiana palmata (Forsk.) Gaud. (Bhansi-sin)

Herb with green flowers. Mallagarkha, 1660 m (5316).

Pilea scripta Wedd.

Herb with minute green flowers. Mallagarkha, 1660 m (5339).

Boehmeria platyphylla Don (Loc. Garpat)

Shrub with nearly white flowers. Mallagarkha, 1660 m (5304).

Pouzolzia zeylanica (L.) Benn.

Herb with green flowers. Mallagarkha, 1660 m (5267).

Debregeasia hypoleuca Wedd. (Loc. Tysyar)

Pubescent shrub with whitish flowers. Daula hill, 2230 m (5399).

MORACEAE

Ficus religiosa L. (Loc. Pipal)

Large deciduous tree with sessile depressed figs. Pali, 1200 m (5287).

F. clavata Wall.

Shrub with solitary ovoid figs. Mallagarkha, 1660 m (5278).

F. hispida L.f. (Loc. Timue)

Small tree with clustered globose figs. Mallagarkha, 1660 m (5208).

F. semicordata Buch.-Ham. ex J.E. Smith (Loc. Khinm.)

Small tree with globose figs. Mallagarkha, 1660 m (5118).

F. palmata Forsk. (Loc. Beru)

Shrub or small tree with edible figs. Mallagarkha, 1700 m (5117).

F. glomerata Roxb. (Loc. Umar)

Tall tree with pyriform figs. Mallagarkha, 1660 m (5207).

JUGLANDACEAE

Juglans regia L. (Loc. Akhrot)

Large tree with green flowers (cultivated). Gangolihat, 2000 m (5170).

MYRICACEAE

Myrica nagi Thunb. (Loc. Kaiphal)

Small dioecious tree with fleshy red drupes. Daula hill, 2500 m (5114).

BETULACEAE

Alnus nepalensis D. Don (Loc. Utees)

A large tree with male drooping catkins. Daula hill, 2230 m (5382).

FAGACEAE

Quercus lanuginosa Don (Loc. Latoo)

Goptari, 2500 m (5144).

Q. incana Roxb. (Loc. Banjh)

Daula hill, 1700 m (5046).

Q. glauca Thunb. (Loc. Kautounj)

Gangolihat, 2000 m (5236).

SALICACEAE

Salix wallichiana Anders. (Loc. Phabs)

Small tree. Daula hill, 2230 m (5106).

S. babylonica L.

Small tree with drooping branches. Rayeagar, 2000 m (5067).

GYMNOSPERMS

PINACEAE

Pinus roxburghii Sarg. (Loc. Chil)

A tall tree, common throughout the area from 1000-1700 m (5350).

Cedrus deodara Loud. (Loc. Deodar)

A large handsome tree with horizontal branches, forming pure communities between 1700-2700 m particularly on northern slopes. (5392).

MONOCOTYLEDONS

ORCHIDACEAE

Microstylis wallichii Lindl.

Terrestrial herb with purplish-green flowers. Goptari, 2000 m (5411).

Dendrobium alpestre Royle

Epiphytic herb with reddish-white flowers. Goptari, 2200 m (5463).

D. amoenum Wall.

Epiphytic herb with purplish-white flowers. Daula hill, 2230 m (5131).

Eria alba Lindl.

Terrestrial herb with fragrant white flowers. Daula hill, 2230 m (5243).

Coelogyne cristata Lindl.

Terrestrial herb with purplish-white flowers. Daula hill, 2230 m (5149).

Pholidota articulata Lindl. var. **griffithii** K. & P.

Epiphytic herb with white flowers. Daula hill, 2230 m (5109).

Cymbidium giganteum Wall.

Epiphytic herb with brownish-red flowers. Daula hill, 2230 m (5179).

Vanda cristata Lindl.

Epiphytic herb with yellowish-green flowers. Bhrugtam hill, 2200 m (5115).

Habenaria edgeworthii Hook.

Terrestrial herb with greenish-yellow flowers. Bhuvaneshwar, 2230 m (5384).

Herminium angustifolium Benth.

Terrestrial herb with small green flowers. Bhuvaneshwar, 2500 m (5409).

Satyrium nepalense Don

Terrestrial herb with fragrant pink flowers. Bhuvaneshwar, 2300 m (5406).

ZINGIBERACEAE

Roscoea purpurea Wall.

Robust herb with dark purple flowers. Daula hill, 2230 m (5371).

Cautleya spicata Baker (Loc. Van haldi)

Herb with yellow flowers. Bhuvaneshwar, 2700 m (5372).

HAEMODORACEAE

Mondo intermedium (Don) Bailey

Tufted herb with white flowers. Bhrugtam hill, 2600 m (5180).

IRIDACEAE

Iris sp.

Perennial herb with purplish flowers. Goptari, 2000 m (5347).

AMARYLLIDACEAE

Hypoxis aurea Lour.

Stemless herb with yellow flowers. Daula hill, 2230 m (5154).

AGAVACEAE

Agave wightii Dr. & Prain (Loc. Rambans)

Perennial herb with rosette of ensiform leaves. Mallagarkha, 1660 m (5314).

DIOSCOREACEAE

Dioscorea sativa L. (Loc. Geeti)

A climber with stem bearing numerous bubils. Mallagarkha, 1660 m (5345, 5393).

D. glabra Roxb.

Climbing herb. Mallagarkha, 1660 m (5313, 5390).

LILIACEAE

Smilax aspera L.

Prickly climbing shrub with white flowers. Goptari, 2000 m (5362).

Polygonatum multiflorum All.

Herb with greenish-white drooping flowers. Daula hill, 2230 m (5158).

Asparagus filicinus Buch.-Ham.

An unarmed climbing shrub. Nandan hill, 2330 m (5192).

A. adscendens Roxb.

A straggling prickly shrub. Nandan hill, 2300 m (5149).

PONTEDERIACEAE

Monochoria vaginalis Presl.

Marshy herb with blue flowers. Mallagarkha, 1660 m (5319).

COMMELINACEAE

Commelina diffusa Burm. f.

Diffuse herb with dark blue flowers. Mallagarkha, 1660 m (5372).

Cyanotis cristata (L.) D. Don

Decumbent herb with blue flowers. Mallagarkha, 1660 m (5335).

JUNCACEAE

Juncus bufonius L.

Tufted herb with green flowers. Mallagarkha, 1660 m (5040).

PALMAE (ARECACEAE)

Phoenix sylvestris Roxb. (Loc. Thakav)

A tall graceful palm. Mallagarkha, 1660 m (5205).

ARACEAE

Arisaema helliborifolium Schott.

Herb with two pedately compound leaves. Mallagarkha, 1660 m (5190).

A. consanguineum Schott. (Loc. Shial Ghoge)

Herb with a solitary leaf. Goptari, 2000 m (5330).

CYPERACEAE

Cyperus brevifolius (Rottb.) Hassk.

A sedge with green spikelets. Mallagarkha 1660 m (5239).

C. paniceus (Rottb.) Boeck.

A sedge with green spikelets. Mallagarkha, 1660 m (5256).

C. distans L.f.

A sedge with dark brown spikelets. Mallagarkha, 1500 m (5302).

GRAMINEAE (POACEAE)

Panicum plicatum Lamk. (Loc. Ganyar)

An erect or ascending grass. Mallagarkha, 1660 m (5212).

Setaria glauca Beauv.

Annual grass with pale brown spikelets. Mallagarkha, 1660 m (5250).

Coix lachryma-jobi L.

Erect annual grass. Mallagarkha, 1660 m (5303).

Erianthus fulvus Nees

Tall grass with greyish-white silky panicles. Mallagarkha, 1660 m (5438).

Alopecurus geniculatus L.

Decumbent herb with yellowish-green spikelets. Mallagarkha, 1660 m (5005).

Themeda triandra Forsk.

Perennial grass with reddish-brown spikelets. Mallagarkha, 1660 m (5312).

Agrostis alba L.

Tufted grass with pale-green spikelets. Mallagarkha, 1660 m (5437).

Sorghum halepense (L.) Pers.

Tall grass with purplish spikelets. Mallagarkha, 1660 m (5354).

Tripogon abyssinicus Nees

A perennial tufted grass. Mallagarkha, 1660 m (5402).

Phragmites communis Trin.

Tall grass with purplish-brown panicles. Daula hill, 2000 m (5059).

Neyraudia madagascariensis Hk.

Tall grass with shining purplish-brown panicles. Mallagarkha, 1660 m (5321).

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On the occurrence of the Hippolytid prawn, *Angasia armata* (Paulson) (Decapoda, Crustacea) in Bombay waters, its cannibalistic behaviour and its larvae

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(*With three text-figures*)

While hauling up bottom-set gill nets on 13th July, 1963, operated in waters of 36 m depth off Versova (Bombay suburban) for catching pomfrets (*Pampus argenteus*) live prawns clinging to the net dropped on the deck. It was thought that the prawn, with its characteristic elongated rostrum, was interesting material. The specimens, which fortunately included ovigerous females, were carefully brought to the laboratory for further observations but unfortunately died.

The prawn was identified as *Angasia armata* (Paulson) (Family: Hippolytidae).

Again in 1967 (19th January), the prawns were obtained in the gill nets and necessary precautions in the form of suitable shelters viz. nylon mops were provided in the tanks and observations were made on their behaviour under captivity.

This paper deals briefly with the taxonomy of the species, its cannibalistic nature in captivity and the two larval stages obtained in the laboratory.

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Angasia armata (Paulson)

(Fig. 1)

Tozeuma armatum Paulson, 1875, p. 99 : Kemp, 1914, p. 106 ; 1916, p. 399 ; Kurien, 1954, p. 70 ; *Tozeuma armata* : Sewell, 1913, p. 350 ; *Angasia armata* : Balss, 1914, p. 48 ; Holthuis, 1947, pp. 61-63.

Description : The present material agrees more or less with that of the Siboga and Snellius expeditions, as described by Holthuis (1947). The rostrum is armed with 24-37 spines on lower border and measures *more than ½ to ¾ as long as rest of the body.* Both, the antennal and pterygostomial spines are present on the carapace. The difference in the antennular-length of male and female specimens is, as pointed out by Holthuis (op. cit.), due to sexual dimorphism ; in the male the inner flagellum of antennule extends to the tip of the antennal scale, whereas in the female the antennule is distinctly shorter than the scaphocerite. In all the specimens, the difference in the size of the posteromedian spines of the 3rd, 4th and 5th abdominal segments was quite distinct, the spine of the 3rd being very high, much compressed with its tip bent backwards, though in 2-3 specimens only this tip was either broken or lost, that of the 4th segment was the smallest and not compressed and that of the 5th was high, compressed and distinctly longer than that of the 4th segment. As in specimens described earlier by Holthuis (1947) and Kemp (1914 and 1916), the pleuron of the 5th abdominal segment bears two spines, one on the upper portion and the other on the lower portion of the posterior margin of the pleuron.

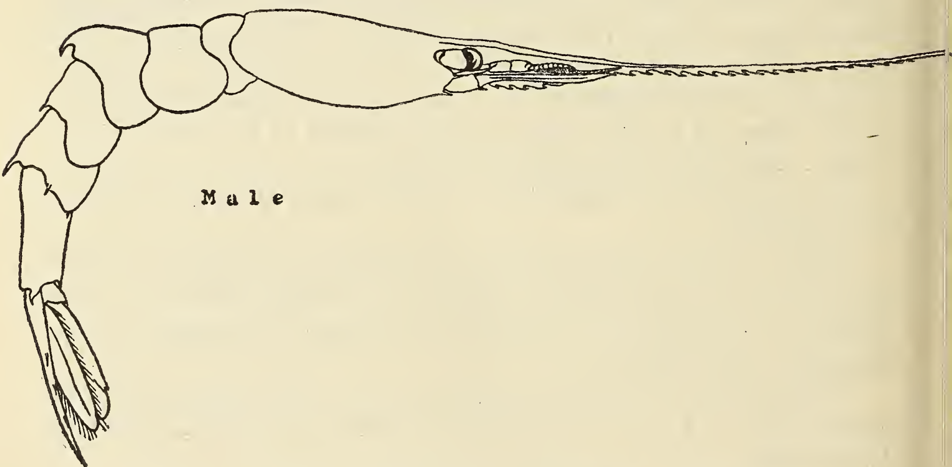

Fig. 1. *Angasia armata* (Paulson) ; adult (legs etc. not shown).

Material examined : 7 ovigerous females (46-59 mm) and 2 males (47-53 mm) collected from a depth of 36 m off Versova (Bombay) in July, 1963. Bottom—muddy.

9 ovigerous specimens of 44 to 47 mm length and 3 males of 41 to 45 mm collected from the depth of 66 m off Thana 40 miles north of Bombay, on 19-1-1967. Bottom muddy with coraline patches.

The colour in life is the same as described by Kemp (1916).

Remarks : *A. armata* has been recorded in Indian waters from Mandapam, Andamans and Burma on the east (Kemp 1916) and on the west from south-west Ceylon and Trivandrum (Kurien 1954). This, the first record of the species from Bombay waters, extends its distribution along the west coast from Trivandrum to north as far as Bombay.

The range of vertical distribution of the species is from 4 to 150 m.

Observations in captivity : In 1963, when these prawns were kept in a small aquarium tank, without shelters like weeds or nylon mops in the tank, the majority of the specimens invariably died within 24 hours. On examination, it was observed that in almost all the dead or dying specimens, the soft part at the junction of the cephalothorax and abdomen was severely injured and the few specimens still alive in the tank were observed to be preying upon on the soft parts of the dead or dying specimens, thus indicating their cannibalistic tendencies. To reduce the rate of mortality from cannibalism and to study the clinging behaviour of the prawns to the gill nets, nylon mops were suspended in the observation tanks.

Three to four mops of nylon fishing twine (210/12/3) were suspended in a small aquarium tank of 9″×12″×6″, by tying each mop to a piece of cork at the top. The prawns immediately took shelter in the mops. After a little while, some specimens started clinging to others by holding on to their backs. When the mops were lifted out of water, most of the specimens, particularly those clinging to each other, did not leave the mops, despite vigorous shaking ; some of the individual specimens darted away, leaving the mop for the water when they were just at the surface of the water. On re-introducing the mop with prawns into the tank, those, which were holding on to other prawns, either lost their grip or continued to hold on; whereas those, which were individually clinging on to the mop, either caught hold of another mop or continued to remain attached.

The behaviour of prawns holding on to each other, was interesting. The carrier-prawn would move vigorously on the mop attempting to dislodge the mounted-prawn.

When the carrier prawn was exhausted the mounted-prawn adjusted itself so as to lock its pereiopods with the pleopods of the carrier-prawn and then attacked the soft part at the junction of the cephalothorax and abdomen, eventually killing the carrier-prawn. Dislodgement was rare and when it occurred, happened within 2-3 minutes. The reasons for cannibalism are not known but on this account, several specimens were lost and to avoid this type of mortality the prawns had to be kept singly.

Larval Stages : Literature on the larvae of the genus *Angasia* reveals that the larvae of only two species namely *Angasia* (=*Tozeuma*) *carolinense* and *A. armata*, have, so far been described. Gurney (1937) described the 1st stage of *A. carolinense*, obtained in the laboratory. He also described two other forms, from the Great Barrier Reef plankton, as *Tozeuma* sp. B.R.I. and sp. B.R.II. In sp. I, he noted stages III to VIII but stage VII was absent. In sp. II, only the VI stage was present. Kemp (1916) described a post larva of *A. armata.*

Each berried female was kept separately in small aquarium tanks provided with sea water and aeration. Adults of *A. armata* inhabit seaweeds and to simulate the natural environment mops of nylon threads were suspended in the tanks, as described earlier in this paper. The prawns took shelter amongst the threads and eggs from two of the females hatched but the larvae could be reared only up to the IInd zoeal stage in the laboratory. The method of rearing was as described elsewhere (Sankolli 1965).

First Stage Larva

(Fig. 2)

Length of carapace	=0·6 - 0·7 mm
Length of rostrum	=1·0 mm
Length of abdomen	=2·5 mm

Larva (Fig. 2, a) is long and slender and characterised by the presence of a long smooth rostrum and a posteromedian process on the 3rd abdominal segment. Eyes are sessile. Rostrum is smooth and longer than carapace. Carapace is smooth with no pterygostomial spine which is present in *A. carolinense* described by Gurney (1937). All the three maxillipeds are functional with 3 apical setae on their exopods. Abdomen is 5-segmented, the 6th segment being still fused to telson. Telson-process formula is 7+7, the 1st process being situated laterally. No anal spine.

Antennule (Fig. 2, b) : The outer ramus bears 4 aesthetascs. The inner ramus is represented by a long plumose seta.

Antenna (Fig. 2, c) : Biramous with a long, somewhat cylindrical scale which bears 10 marginal setae ; the outermost seta is a minute, delicate hair and the remaining are plumose. The distal part of the scale shows segmentation. Endopod is a long, narrow rod-like process which is serrated on its outer margin and is slightly longer than the scale. Ventral spine is present on the peduncle.

Mandible (Fig. 2, d): Mandibles of either side are slightly asymmetrical. The arrangement and structure of the teeth on the cutting edges is almost similar to that of *A. carolinense.*

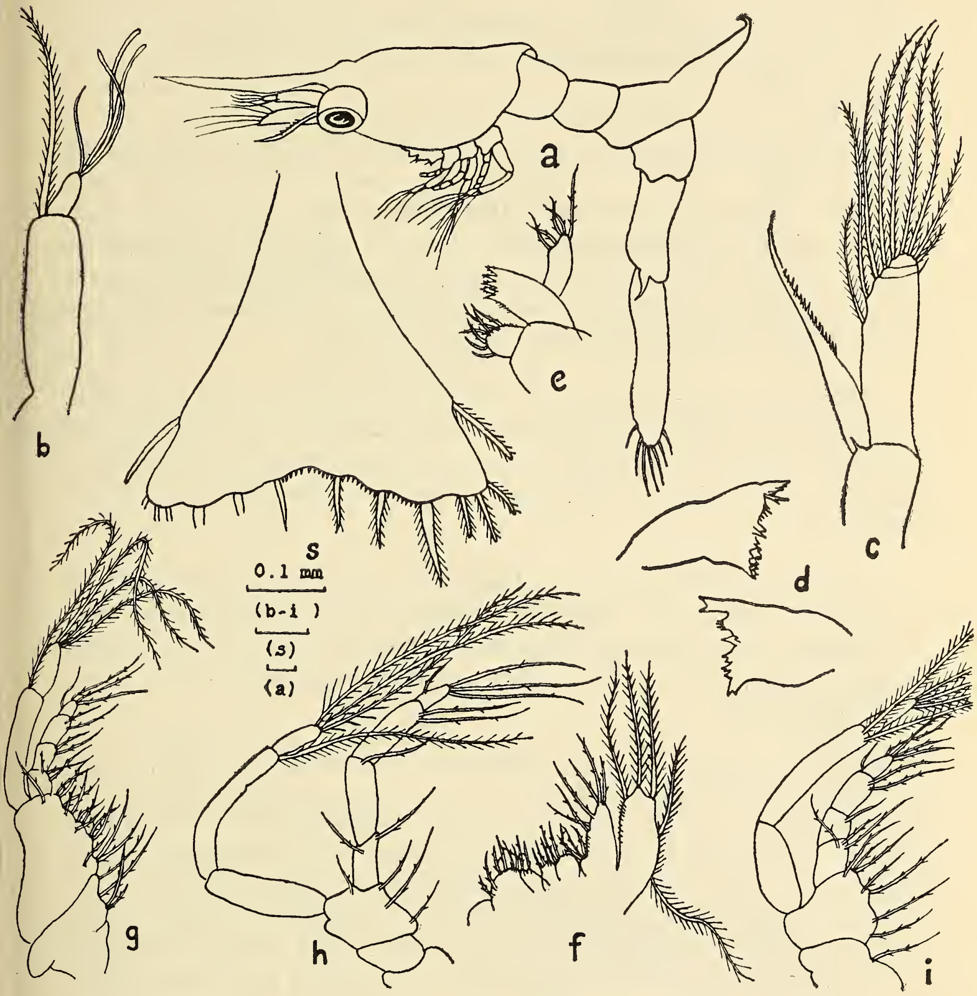

Fig. 2. *Angasia armata* (Paulson), First stage: (*a*) entire larva; (*b*) antennule; (*c*) antenna; (*d*) mandibles; (*e*) Ist maxilla; (*f*) IInd maxilla; (*g*) Ist maxilliped; (*h*) IInd maxilliped; (*i*) IIIrd maxilliped; (*s*) telson.

First maxilla (Fig. 2, e) consists as usual, of a coxal and basal endites and a simple unsegmented palp. The coxal endite is armed with 6-7 bristle-like setae whereas the basal has 5-6 unequal serrated teeth. Palp shows a slight distal notch and bears in all 5 setae in 3 groups of 2, 2 and 1.

Second maxilla (Fig. 2, f) is of the usual form with setose coxal and basal endites, an endopod and a scaphognathite. Endopod has three inner lobes, the basalmost alone being very distinct. The arrangement of setae on endopod is 3 apical and 1, 2 and 3 on the 3 inner lobes. Scaphognathite bears 5 marginal plumose setae, the posterior seta being longer than the rest. There is a fringe of fine hairs on the inner margin of endopod and scaphognathite, and also on the outer margin of scaphognathite.

First maxilliped (Fig. 2, g): Endopod is 4-segmented and shorter than exopod. The first 3 segments bear 2 setae each on their inner margin. The last segment has 3 long terminal and 1 small outer setae. Exopod shows 3 indistinct segments and bears 3 apical and 1 subterminal setae. Basis is quite large, almost equal to the length of endopod and is lined with setae on the inner margin. Coxa has a prominent projection on outer margin and bears 4 setae.

Second maxilliped (Fig. 2, h): Endopod is similar to that of the first maxilliped but with 4 terminal setae on the last segment. Exopod bears 3 apical and 2 subterminal setae instead of 3 and 1 of the first maxilliped. Basis is much shorter than that of the first maxilliped and bears fewer setae.

Third maxilliped (Fig. 2, i): Endopod is 4-segmented and is almost as long as exopod. The first three segments bear 2, 1 and 2 setae each and the last segment which is the smallest, bears 1 small outer and 3 long terminal setae. Exopod is as in the first maxilliped with 3 apical and 1 subterminal setae.

Other appendages : No pereiopod buds develop at this stage.

Abdomen : It is 5-segmented, the 6th segment being still fused to telson. The first 4 segments are slightly longer than broad and of about equal size. The 3rd segment has a characteristic posteromedian process which is pointed at the tip and directed forwards. This process is also present in *A. carolinense* but is smaller than in *A. armata.* The 5th abdominal segment is the longest, twice longer than broad and with a pair of large posterolateral spines as in *A. carolinense.* No pleopod buds.

Telson (Fig. 2, s): Somewhat triangular in outline with its proximal portion elongated and narrow. Process formula is 7+7, the 1st process is laterally situated. The posterior margin is slightly convex with a wide shallow median notch. In *A. carolinense*, all processes are of equal length but in the present species, only the 2nd to 4th are short but of equal length and rather closely placed ; the 5th is the longest process. The 5th to 8th processes are more widely placed. The 1st to 4th processes terminate bluntly, while the other processes are sharp. The posterior margin, in between processes 5 to 8, is serrated with minute spinules. No anal spine.

SECOND STAGE LARVA
(Fig. 3)

Length of carapace = 0·8 mm
Length of rostrum = 1·2 mm
Length of abdomen = 3·2 mm

This differs from the first stage in the following characters: larger size, stalked eyes, endopod of the IInd and IIIrd maxillipeds 5-segmented and

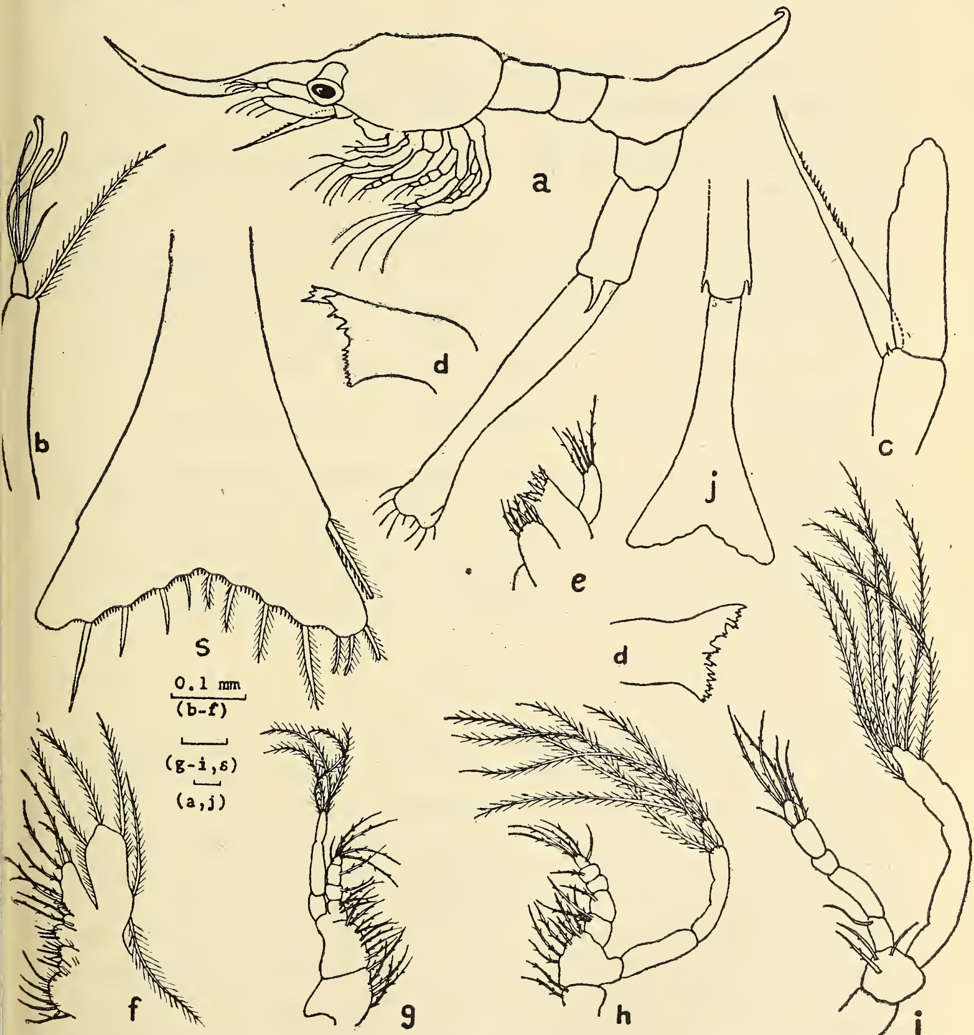

Fig. 3. *Angasia armata* (Paulson) Second stage: (*a*) entire larva; (*b*) antennule; (*c*) antenna; (*d*) mandibles; (*e*) 1st maxilla; (*f*) IInd maxilla; (*g*) Ist maxilliped; (*h*) IInd maxilliped; (*i*) IIIrd maxilliped; (*j*) abdomen showing spines of 5th segment; (*s*) telson.

exopods of the 3 maxillipeds bearing 4 apical setae each; telson process formula 8+8.

Antennule (Fig. 3, b): Except for an additional aesthatasc on the outer ramus, there is no other change from stage I.

Antenna (Fig. 3, c): Unfortunately, this appendage was not completely free from the moult of stage I. The number of setae on the scale, therefore, could not be ascertained. Endopod, however, is unchanged.

Mandible (Fig. 3, d): No appreciable change. No palp is formed as yet.

First maxilla (Fig. 3, e): No change except for slight increase in the number of setae on the coxal and basal endites.

Second maxilla (Fig. 3, f): The coxal and basal endites, become more setose.

Maxillipeds : Except for the increase in number of setae an exopod which is 4, 6 and 7 respectively on the 1st, 2nd and 3rd maxillipeds (Fig. 3 g, h, i), there is no appreciable change.

Other appendages : No traces of pereiopod buds.

Abdomen : There is no change except for increase in size.

Telson (Fig. 3, s): It becomes a little narrower and more elongated than that in 1st stage. Process formula is 8+8 and the 1st to 4th processes are blunt and remaining processes are sharp as in previous stage. The median notch of the posterior margin becomes narrower and the 8th pair of processes is situated on the border of the notch.

Discussion

The 1st stage larvae of *Angasia armata* are similar to those of *A. carolinense* described by Gurney (1937). The pterygostomial spine of carapace is, however, wanting in the present species.

Based on the knowledge of the above 2 species, the early stages of *Angasia* can be distinguished by (1) long rostrum, (2) antennal endopod long, narrow and serrated, (3) mandibles with peculiar pectinate type of teeth, (4) Exopods of maxillipeds with 3 apical setae in stage I and 4 setae in stage II, (5) Telson with long, narrow basal portion widening distally, process formula 7+7 with the 1st process being situated on the lateral margin; no anal spine, (6) 3rd abdominal segment with a characteristic prominent, posteromedian spine and the 5th with a pair of posterolateral sharp spines.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—12

Apodidae and Trogonidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **69** (1) : 129]

683 **Collocalia brevirostris brevirostris** (Horsfield) (Assam) Himalayan Swiftlet (*C. fuciphaga brevirostris*, part) **4** : 348

8 : 3 ♂♂ 4 ♀♀ 1 o ?

1 Tara Devi, Patiala, 1 Bhajji State 4000′; 1 Simla, 1 Keonthal State 8500′, 1 Mashobra, Koti State 7000′ ; 1 Buina, Chabrata, 1 Dakuri, Kumaon, U.P. ; 1 Bhutan Duars.

	Wing	Bill	Tarsus	Tail
♂♂	124, 125 (2)	4, 5 (2)	8, 9, 10	48, 54, 55
♀♀	120, 121, 126, 127	5 (4)	8, 9 (3)	53 (2), 54, 56
	(IH ♂♀ 120-133	—	*c.* 8	54-59)

684 **Collocalia brevirostris innominata** Hume (Andaman Islands ; type from Port Mouat, S. Andaman Island) Hume's Swiftlet **4** : 349

nil.

684a **Collocalia maxima maxima** Hume (Tenasserim) Indo-Malayan or ' Black-nest ' Swift (*C. b. brevirostris*, part) **4** : 348

1 ♀ *Lalang Tioman, Malaya.* Wing 131 (IH 128-135) ; tail 54 (IH 50-58)

The tarsus is feathered and the downy bases of the rump coverts are black with a small white patch at the upper end (as per Sims, *Ibis*, 1961, 205-209).

685 **Collocalia unicolor** (Jerdon) (Coonoor Pass) Indian Edible-nest Swift **4** : 346

11 : 5 ♂♂ 1 ♀ 5 o ? (1 juv.)

8 Vengurla, Ratnagiri ; 1 Gudalur, Nilgiris ; 1 Kodaikanal ; 1 Karimba, 15 m west of Palghat Gap.

	Wing	Bill	Tarus	Tail
♂♂	113-117 av. 115	5(5)	7, 8(2), 9(2)	50(2), 51(3)
♀	114	5	8	50
♂♀	111, 112, 113, 115	4(2), 5(2)	8(3), 9	50, 52(2), 53
	(IH ♂♀ 113-117	—	—	48-55)

686 **Collocalia fuciphaga inexpectata** Hume (Andaman Islands) Andaman Greyrumped or 'White-nest' Swiftlet 4 : 350

3: 2 ♂♂ 1 ♀ (two nests Chirria Tapoo)
2 Long Island, Middle Andamans, 1 Wrightmyo, South Andamans.

	Wing	Bill	Tarsus	Tail
♂♂	116, 116 ; ♀ 113	4, 5 ; ♀ 4	9, 10 ; ♀ 9	48, 52 ; ♀ 50
	(IH ♂♀ 113-121	*c.* 4-5	*c.* 9	49-53)

With the material available it is not possible to comment upon the affinities of these difficult birds, except to mention that the downy part of the feathers of the rump are bordered white. This together with the all-white nest would make this a race of *C. francica* or *brevirostris* of Sims (loc. cit.) rather than *fuciphaga* !

687 **Collocalia esculenta affinis** Beavan (Port Blair, South Andaman Island) Beavan's or Whitebellied Swiftlet 4 : 352

11 : 2 ♂♂ 6 ♀♀ 3 o ? (1 juv.) (two nests)
1 Port Blair, 3 Chiria Tapoo, South Andamans, 1* Andamans ; 2 Car Nicobar ; 4 Camorta, Central Nicobars.

There is no difference in size, but the southern birds appear slightly different and it may be possible to separate them with a well-prepared series.

The sexes show no differences in size :

	Wing	Bill	Tarsus	Tail
♂♀	92 (Camorta)-102 (S. Andaman)	c. 4	c. 8	36-40 av.38·7
	(91-100	c. 3-4	8-9	36-39)

Specimen No. 22600 from Camorta has one white feather on the rump. The juvenile Sp. No. 11654* with wings and tail in quill has an all-brown throat and breast, which is very different from that of the adult.

EL **Collocalia esculenta** subsp.

2 o ?
1 *Fraser's Hill, Malaya.* Wing 109 ; bill 5 ; tarsus 9 ; tail 38.
1 *Ampawa, Selangor.* Wing 96, bill 4.

Both have their underparts slightly darker than in *affinis*. However, it is impossible to determine which one, or two, of the 19 races accepted in Peter's CHECKLIST (1940) between the Andamans and the New Hebrides they represent.

688 **Chaetura caudacuta nudipes** (Hodgson) (Nepal) Whitethroated Spinetail Swift 4 : 340

1 ♀ Kashmir
Wing 198 (196-209) ; bill 8 (7-8) ; tarsus 17 (*c.* 17) ; tail 54 (51-57).

EL **Chaetura caudacuta caudacuta** (Latham) (New South Wales) Spinetail Swift

1 ♀ *U.S.S.R.* Wing 202 ; bill 8 ; tarsus 17 ; tail 51.

This race has a small patch of white on the forehead.

689 **Chaetura (caudacuta) rupchandi** Biswas (Hitaura, central upper Nepal) Rupchand's Spinetail Swift.

nil.

690 **Chaetura (caudacuta) cochinchinensis** Oustalet [Saigon, Cochinchina, (South Vietnam)] Cochinchina Spinetail Swift **4** : 342

nil.

691 **Chaetura gigantea indica** Hume (Andaman Islands and southern India) Brownthroated Spinetail Swift **4** : 343

8 : 2 ♂♂ 3 ♀♀ 3 o ?

1 Gudalur, Nilgiris ; 1 High Range, Kerala ; 2 Golaghat, Assam ; 1 Long Island, Andamans ; 1 *Katha*, 1 *Pokokku, Upper Burma*, 1 *Bankachon, S. Tenasserim.*

	Wing	Bill	Tarsus	Tail
♂♀	189-195 (one 200)	8-10 av. 8·5	16-19 av. 17	53-64 av. 58·5
	(IH 188-200	from skull 13-16	16-18	54-60)

There is a varying amount of white on the chin. In Nos. 11627 and 11629 both from Burma, the white spots on the forehead are very indistinct and they show almost no white on the chin.

692 **Chaetura sylvatica** (Tickell) (Central India, restricted to Maunbhum) Whiterumped Spinetailed Swift **4** : 344

3 : 2 ♂♂ 1 ♀

1 Thattakad, N. Travancore ; 2 Pithabhata, Mayurbhanj, Orissa.

♂♀	112, 113, 113	4, 4, —	7, 8, 8	35, 37, 37
	[IH (107) 112-116	—	c. 8-9	34-37]

The fine dark shafts of the white feathers of the rump appear more consistent in the single male from Travancore than in the others.

693 **Apus melba melba** (Linnaeus) (Gibraltar) Alpine Swift **4** : 324

nil.

In 1965 (*JBNHS* **62** : 153-160) I have dealt with the races occurring in India and indicated my inability to identify any of the Indian specimens available for examination as nominate *melba*. There appears to be no reason to revise this opinion, though IND. HANDBOOK (**4** : 39) identifies specimens from Mt. Abu and Hingolgadh as of this race (see 695c below).

694 **Apus melba nubifuga** Koelz (Rathi, Kumaon) Himalayan Alpine Swift

7 : 4 ♂♂ 2 ♀♀ 1 o?
1 Chitral, N.W.F.P. ; 4 Simla ; 1 Ghaggar, Ambala, Punjab ; 1 Chomali, Garhwal.

The measurements are under 695c.

695 **Apus melba bakeri** Hartert (Catton Estate, 4500′, Ceylon) Ceylon Alpine Swift

5 : 2 ♂♂ 2 ♀♀ 1 o?
2 Kumta, 2 Jog (Gersoppa), 1 N. Kanara.

These birds are not quite the same as those from Ceylon and, as suggested by Vaurie (*Am. Mus. Nov.* 1971, p. 22), it may be best to leave them with more northern Indian birds i.e. *dorabtatai.*

695a **Apus melba tuneti** Tschuschi (Tunis)

1 ♂ Apte on Patalganga, Kolaba, Maharashtra.
Wing 226, tail 83.

As already noted (see remarks under 695c below) this is outstandingly larger than the others and further distinguished by the finely tapering feathers of the tail. Meinertzhagen (*Ibis*, 1938, p. 127) and Paludan in *On the Birds of Afghanistan* (1959, p. 127) refer birds from Afghanistan to this subspecies.

695b **Apus melba dorabtatai** Abdulali (Ghoti, Nasik)

7 : 2 ♂♂ 5 ♀♀ (* including type specimen)
1 Chikalda, Berar ; 3* Ghoti, Nasik, 1 Tungar, Bassein, Thana, 2 Yewat, Poona.

Though not larger than the south Indian birds listed under *bakeri*, these are smaller than *nubifuga* and have broader breast bands than both *bakeri* and *nubifuga.*

The measurements are under 695c.

695c **Apus melba** subsp.

4 : 1 ♀ 3 o?
1 Mt. Abu, Rajasthan ; 3 Hingolgadh, Saurashtra.

These birds are accepted as of the nominate form in IND. HANDBOOK. I have earlier (*JBNHS* **62** : p. 158) referred to their being paler than nominate *melba*, and agreeing with *tuneti* except for the fact that the outermost tail feathers do not taper to a point as appears to be characteristic of that race. Without the opportunity of examining and comparing them with a larger series of *tuneti* and *melba*, I would prefer to leave them undetermined. The different subspecies measure :

		Wing	Tail
A. m. melba	♂♂	220-228	77-90
(ex Witherby)	♀♀	207-221	—
A. m. nubifuga	♂♀	208-216 av. 213	70-83 av. 75·5
A. m. bakeri	♂♀	196-207 av. 202	70-78 av. 73
A. m. dorabtatai	♂♀	194-205 av. 200·5	62-77 av. 71
A. m. subsp. 695c.	♂♀	209, 215(2), 216	70(2), 71, 71

Though BRITISH HANDBOOK indicates that the males are larger than the females, there is no evidence in the material available that there is any difference in size between the sexes in the forms assumed to be resident in Indian limits. In view of the limited number of specimens available, the measurements of both sexes are listed together.

696 **Apus apus pekinensis** (Swinhoe) (Pekin, China) Eastern Swift 4 : 326

10 : 4♂♂ 4♀♀ 2 o?

1 *Birjand*, 1 *Shiraz, Persia* ; 1 *Marghab, Herat, Afghanistan* ; 1 *Kashgar* ; 1 Malakand, 2 Chitral, N.W.F.P. ; 3 *Peking, China.*

	Wing	Tail
4 ♂♂	169, 170, 172, 174	70, 72, 74(2)
4 ♀♀	167, 170(2), 173	68, 70, 71, 76

A female from Marghab, Afghanistan (wing 167, tail 70) is blacker above, particularly on the head, and the white chin is barely visible. Meinertzhagen in Birds of Northern Afghanistan, (*Ibis*, 1938, p. 695) and Paludan (1959, *On the Birds of Afghanistan*, p. 128) identify Afghan birds as *pekinensis*.

The juvenile from Malakand has whitish edges to the feathers of the wing and tail.

697 **Apus pallidus** (Shelley) (Egypt) Pale Brown Swift 4 : 327

4 : 1♂ 1♀ 2 o? (1 pull.)

3 *Muscat, Arabia* ; 1 *Ahwaz, Persia.*

The pullet from Muscat has its wing and tail quills not yet fully grown, and with whitish edges.

698 **Apus acuticaudus** (Jerdon) (Nepal) Dark-backed or Khasi Hills Swift 4 : 327

nil.

699 **Apus pacificus pacificus** (Latham) (New South Wales) Large Whiterumped Swift 4 : 329

nil.

When reporting the occurrence of *Apus p. leuconyx* at Bombay (*JBNHS* **60** : 731-733), I drew attention to the absence of any evidence of the nominate form in Indian limits. IND. HANDBOOK includes it, but I do not know if this aspect has been re-examined. Four specimens from Australia, Korea, and Siam borrowed from the U. S. Nat. Museum are much larger than all those available in Bombay.

700 **Apus pacificus leuconyx** (Blyth) (Calcutta) Blyth's or Himalayan Whiterumped Swift 4 : 331

6 : 2 ♂♂ 4 ♀♀

1 Keonthal State, Simla Hills, 1 Tara Devi, Patiala ; 2 Yoshimath, 1 Ukkimath, Garhwal, U.P. ; 1 Bombay City.

These birds are smaller than those under *kanoi.*

	Wing	Bill	Tail
♂♂	155, 162	6	64, 73
♀♀	154, 155, 156, 161	6	66, 70(2), 72
	(147-160)	(*c.* 7)	(65-71)
kanoi ♂♂	174	7	69
kanoi ♀♀	165, 168, 179, 180	6(2), 7	66, 75, 76(2)
	(IH ex Lack 5 ♂♂	173-179 av. 176)	

As in specimens of *kanoi,* fresh skins are darker and less brown than older ones.

701 **Apus pacificus kanoi** (Yamashina) (Botel Tobago)

5 : 1 ♂ 4 ♀♀

4 Golaghat, Assam ; 1 *Kyibui, Henzada, Burma.*

The measurements are under No. 700 *leuconyx.*

Among the four from Golaghat two (1 ♂ No. 11578 and 1 ♀ No. 11580) have white chins, while the others, both female (Nos. 11579 and 11581), have a lot of brown on the chin, and the bill viewed from below looks wider and larger, but this difference is not supported by the measurements either from forehead or from skull. The two latter females are dated 1 September 1920, while one of the former is 2 September and the other 11 August. Sp. No. 11578 differs in having no barring on the underparts, the feathers having no white tips.

Sp. No. 11576 from Henzada appears a little darker, and shows more shaft streaks both on the white of the chin and upper breast and on the rump. It approaches *cooki* but as it has been named *kanoi* at the British Museum (N.H.) I am leaving it unchanged. If north-eastern birds should be found to differ from *kanoi,* Lack's name *salimalii* (Molo, Chu Valley, SE. Tibet) is available.

EL **Apus pacificus cooki** (Harington) (Goktik, N. Shan States) Burmese Whiterumped Swift 4 : 330

1 ♂ *Hsipaw S., N. Shan States* Wing 174 (163-172) ; tail 67(67-73).

This was collected by J. P. Cook in August 1913 after description of this form (1912). The feathers of the chin are more brown than white, the latter colour being restricted to the distal half of the feather of which the shaft is brown, leaving very little white visible. The underparts are more prominently tipped with white than any of the others, while the white on the rump is narrow and the feathers are streaked with black.

The first primary is equal to or barely longer than the second, a character sufficient to separate this specimen from all the others of the species available, as well as nominate *pacificus*.

702 **Apus affinis galilejensis** (Antinori) (Sea of Galilee, Palestine)
Palestine House Swift **4** : 334

13 : 8 ♂♂ 5 ♀♀ (2 Nos. 20952 and 20953 missing)
1 *Wadi Amud, Palestine* ; 12 Mauripur area, Karachi.

I have already (1966) dealt with the races occurring in India (*JBNHS* **62** : 521-528) and there is very little additional material to report upon.

At the Zoological Survey of Pakistan, Karachi, I had a look at some 60 specimens collected at Mauripur and measured :

10 ♂♂ Wing 128-135 av. 130·6.
10 ♀♀ Wing 125-133 av- 130·4.

A few juveniles with wing quills in moult have greyish foreheads.

703 **Apus affinis affinis** (J. E. Gray) (Ganges restricted to Cawnpur by Stuart Baker) Indian House Swift **4** : 332

43 : 22 ♂♂ (4 pull. 2 juv.) 13 ♀♀ (1 pull.) 8 o ? (1 pull.)
1 Bhagat State, 2 Patiala State, 1 Jullunder, 4 Ambala, Punjab ; 1 Delhi ; 2 Mt. Abu, Rajasthan ; 6 Hyderabad, Sind ; 1 Bhujia Fort, Kutch ; 1 Indore ; 5 Nasik, 10 Bombay, 1 Kihim, Kolaba ; 1 Chanda ; 2 Cudappah, A.P. ; 2 Baghowni, Tirhut ; 1 Garhwal, U.P. ; 1 Calcutta Museum, 1 no data.

There is variation in colour and size. The largest birds are from the north and the smallest from the south. The series from Hyderabad, Sind, resembles *galilejensis* in the breadth of the white on the rump, but the white on the forehead is not so consistent as in that form. Both these races have their tails consistently paler than their backs.

	Wing	Tail
♂♂	121 (Seshachalam Hills)-132 (Ambala)	38 (Koduru, S. Cudappah)-42 (Garhwal)
♀♀	122 (Kihim)-131 (Patiala)	38 (Darbhanga)-44 (Patiala)

Pullets from Ambala, Mt. Abu, and Bombay do not show the grey foreheads as in *galilejensis*.

704 **Apus affinis singalensis** Madras (Ceylon) Ceylon House Swift
4 :334 (part)

nil.

2 specimens from Seshachalam Hills and Koduru, S. Cuddapah, which are the southernmost available, are small (♂♂ wing 121, 124), but the tails are paler than the back and they are left with nominate *affinis*.

705 **Apus affinis nipalensis** (Hodgson) (Central region of Nepal) Nepal House Swift **4** : 334

7 : 4 ♂♂ 1 ♀ 2 o?

1 Bombay City ; 1 Nepal Valley ; 2 Darjeeling, 2 Kurseong ; 1 Haflong, N. Cachar.

The stray into Bombay (No. 22056) which prompted the earlier note (*JBNHS* **62** : 521-528) is included with this form, though both wing and tail are larger than in the others : 143 cf. 126-135 (IH 129-139), and 50 cf. 42-46 (IH 42-49). Another, No. 22287 ♂ from Darjeeling, has the upperparts glossy black, as in *subfurcatus*, but differs from topotypical specimens in its broader white rump and shorter tail. Though not mentioned by Biswas (*JBNHS* **58** : 119) it must be borne in mind that Scully (A Contribution to the Ornithology of Nepal, *Stray Feathers* **8** : 235) particularly stresses the fact that it is away in winter, returning in the first week of March and remaining present till the end of November. The determination of their winter quarters may help to reduce some of the difficulties regarding the subspecies in eastern India.

706 **Apus affinis subfurcatus** (Blyth) (Penang) Malay House Swift **4** : 335

2 : 1 ♂ 1 ♀ *Fraser's Hill, Malaya.*

The wings and tails are longer than in the others, the colour is blacker, and the upper surface of the tail is similar to the back. The white patch on the rump is very narrow and the white feathers both on the chin and the rump have dark shaft streaks, a character rare in the other races.

Wing ♂ 130 ♀ 135 (130-142) ; tail 49, 51 (44-47)

Hume (*Stray Feathers* **2** : 524) refers to a specimen obtained north of Chanda, which he compared with the type of *subfurcatus* and found identical [Wing 5·35″ (136 mm) ; tail from vent fully 2″ (51 mm)].

707 **Cypsiurus parvus batasiensis** (J. E. Gray) (India=Calcutta) Indian Palm Swift **4** : 336

16 : 10 ♂♂ 4 ♀♀ 2 o?

1 Bassein, Thana, 1 Andheri, 1 Pali Hill, 4 Trombay, 1 Uran, Bombay ; 1 Cape Comorin ; 1 Kurumbapatti, Salem ; 1 Cuddapah, Kurnool Dt. ; 1 Jeypore Agency, Vizagapatam ; 1 Devribund, Orissa ; 1 Madhubani, Bihar ; 1 Benares ; 1 Sarun, Bengal (?).

	Wing	Bill	Tarsus	Tail	Fork
♂♀	112-120 av. 116	5	8-9	54-66 av. 61·6	33-35
	(IH 113-122	from skull 7-8	8-9	60-68	30-35)

There is considerable variation in the amount of grey/brown on the underparts as also the relative uniformity of the colour of the upperparts. As indicated by Whistler (*JBNHS* **38** : 32) the large proportion of poor and greasy skins makes it difficult to determine the significance, if any, of these differences. *Batasiensis* (Calcutta) and *palmarum* (Cawnpur) are perhaps synonymous but series from other parts of the country with a better understanding of the plumages may be of interest.

708 **Cypsiurus parvus infumatus** (Sclater) (Banjermassing, Borneo) Eastern Palm Swift **4** : 338

3 ♂♂ (1 juv.)
1 Bhutan Duars ; 1 Lakhimpur Valley, S. Sylhet ; 1 Haigagul, N. Cachar.

The specimen from Bhutan Duars, extended the accepted range of this subspecies (*JBNHS* **69** : 186).

	Wing	Tail	Fork
♂♂	117, 120, juv. 114	55, 56, juv. 67	15, 17
	(♂♀ 113-126)		

The juvenile has a smaller bill and wing, but the tail 67 is longer than in the adults. The upper breast and chin are almost white, and the lower belly brownish, very similar to that noted in Bombay birds, but darker, possibly due to the method of preparation.

709 **Hemiprocne longipennis coronata** (Tickell) (Jungles of Borabhum and Dholbhum) Crested Tree Swift **4** : 354

29 : 19 ♂♂ (2 by plumage, 1 juv.) 10 ♀♀
2 Dohad, 2 Mathar, Narbada Valley, 1 Junna, Rajpipla, Gujerat ; 1 Wada, Thana, 2 Veral, Ratnagiri ; 3 N. Kanara, 1 Shimoga, Mysore ; 1 Nilambur Valley, 1 Gangavadori, Palnis ; 1 Kottayam, Kerala ; 1 Palkonda Hills, 1 Jeypore Agency, Vizagapatam, A.P. ; 1 Kamili, 2 Bailadila, Bastar, 2 Bhanuprattapur, Kanker, M.P. ; 3 Rampur State, 1 Devkund, 1 Chota Nagpur, M.P. ; 2 *Hsipaw, N. Shan States, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	150-163 av. 155	6	8-9	120-132 av. 125
	(IH 141-156	—	7-9	110-135)
♀♀	150-159 av. 154·5	6	8-9	117-132 av. 125
	(IH 148-160	—	7-9	124-127)
	(♂♀ 151-165	about 7	about 7-8	117-135)

There is nothing to suggest that there is any difference in size between the sexes.

710 **Harpactes fasciatus legerli** Koelz (Foot of Mahendragiri, Orissa) Central Indian Trogon

17 : 7 ♂♂ (1 juv.) 10 ♀♀
7 Surat Dangs ; 1 Suriamal, Thana ; 1 Borivli Hills, Bombay ; 1 Anantagiri, Vizagapatam; 1 Geedam, 1 Kameli, Bailadila, 1 Dabra, Bastar C.P., 1 Barkul, Chilka Lake, 2 Badrama, Bamra, 1 Koira, Bonai, Orissa.

	Wing	Bill	Tarsus	Tail
♂♂ *legerli*	130-134 av. 132	17-19	16-17	165-179 av. 172
	(IH 130-142	—	15-17	155-184)
♂♂ *malabaricus*	126-130 av. 128	17-18	15-18	157-164 av. 161
	(IH 122-129	—	13-15	156-180)

♀♀ *legerli*	125-133 av. 128	16-18	15-26	155-170 av. 160
	(IH 125-135	—	15-17	143-176)
♀♀ *malabaricus*	122-130 av. 125	15-18	15-17	152-162 av. 158
	(IH 122-131	—	13-15	162-167)

The birds from the immediate neighbourhood of Bombay appear nearer to *legerli* than to *malabaricus*. One is marked *malabaricus* by Whistler but this was prior to description of this race.

711 **Harpactes fasciatus malabaricus** (Gould) (Malabar Coast) Malabar Trogon 4 : 317

16 : 9 ♂♂ (1 by plumage) 7 ♀♀

1 Talewadi, Belgaum ; 1 Morda, 1 Karunal, Goa Frontier, 1 Jog, 4 North Kanara ; 1 Makut, S. Coorg, 1 Coonoor Ghat, Nilgiris ; 1 Tenmalai, C. Travancore, 1 Perren Goddu, (Travancore ?) ; 2 Manalur, Palnis ; 1 Kuriakutti, Cochin ; 1 Madura, S.I.

Both males and females show a greater amount of variation in colour than those under *legerli*. Some of the males from North Kanara are pink rather than red below. The rufous above in both sexes and below in females is distinctly deeper than in *legerli*, and the measurements (under *legerli*) also smaller. The underparts of two females from Perren Goddu and Bakemani, N. Kanara, are noticeably darker than in the others.

The 20°N. latitude has been suggested as the dividing line between *legerli* and *malabaricus*. While opinions may differ about the birds from around Bombay (*c.* 19°N) being nearer *legerli* or *malabaricus*, the dividing line cannot be extended eastwards, and the birds from the Nallamalai Hills and Sankrametta, Vishakhapattam district, be accepted as *malabaricus* as appears to have been done in IND. HANDBOOK (4 : 62). In addition to the type locality of *legerli* being quite near, and south of 20°N, a breeding female (Sp. No. 11516) obtained in the Vizagapatam Hills (wing 128, *JBNHS* **45** : 343) is definitely *legerli*.

712 **Harpactes fasciatus fasciatus** (Pennant) (Ceylon) Ceylon Trogon 4 : 316

nil.

Harpactes erythrocephalus

Peter's *Checklist* covers 10 races ranging from Nepal eastwards, of which only the nominate form is accepted for Indian limits in Stuart Baker's FAUNA. IND. HANDBOOK recognizes three races but, though there are differences, it is not possible to separate the specimens available with any degree of certainty. I am for the moment listing them largely on the basis of the geographical distribution in IND. HANDBOOK with notes on the difficulties noticed. I cannot see any appreciable differences in the wing/bill index referred to.

713 **Harpactes erythrocephalus hodgsonii** (Gould) (Hitaura, Chisapani, Garhi Province, Nepal) Nepal Redheaded Trogon

8 : 3 ♂♂ 5 ♀♀

3 Kurseong Dist., 1 Longview Tea Estate, 1 Balasun Valley, Darjeeling ; 1 Bagho Bahar, Cachar ; 1 Laitkynsew, Khasi Hills ; 1 Rema Tea Estate, S. Sylhet.

	Wing	Bill	Tarsus	Tail
♂♂	142, 145, 146	18, 19, 20	18(3)	170, 176, 179
	(IH 142-161	from skull 18-22	18-20	176-207)
♀♀	143-147 av. 146	18-21 av. 19	17-20	170-182 av. 175·5
	(IH 144-154	from skull 19-22	18-20	180-201)

All three males are from south of the Brahmaputra, i.e. Cachar, Khasi Hills, and S. Sylhet, while four of the females are from the north. They show no differences in size or in colour except that normally accepted between the sexes.

The female from Balasun Valley (wing 147, tail 173) is startlingly different from the others, being a much brighter red (almost scarlet) on the underparts, resembling the series from Bhutan (not yet registered) and referred to under No. 714 (*helenae*).

It may be recalled that a similar affinity between *Glaucidium cuculoides* from Balasun Valley and Bhutan was noticed under No. 641 (*G. c. rufescens*).

714 **Harpactes erythrocephalus helenae** Mayr (Nyetmawhka, 8500 ft., Myitkyina Dist., Upper Burma)

14 : 4♂♂ 6 ♀♀ 4 o ?

1 Changchang Pani, 1 Golaghat, 2 Margherita, 1 Denning 2300′, 1 Tezu 650′, Lohit Valley ; 2 Rotung, Abor Valley, 1 Moya, Mishmi Hills, Assam ; 2 *Gora*, 1 *Dungughlia*, 1 *Lakhawka, Chindwin* ; 1 *Myitkyina Dt., Burma.*

Two (♂ 11553 and ♀ 11552) from Denning 2300′ and Tezu *c.* 650′, in Lohit Valley, Assam, are almost as bright red as those from Bhutan but, though the ♂ has a 160 mm. wing, the female is only 145. Of the seven unregistered birds from Bhutan, two males from east Bhutan are redder than the others. The Bhutan birds measure :

	Wing	Bill	Tarsus	Tail
5 ♂♂	151-155	18-20	17-18	185-196
2 ♀♀	152, 153	18(2)	17-19	188-193

and the others :

4 ♂♂	145(2), 150, 160	18, 19(2), 20	18(3), 22	170, 176, 177, 181
6 ♀♀	143-153 av. 147	18-21 av. 19	18-21 av. 19	172-182 av. 177
	(IH ♂♂ 152-164,			
	♀♀ 146-168	—	—	♂♀ 180-218)

One female (No. 11543) from Maya, Mishmi Hills, (27 December) has very little red on the underparts which are almost white.

The type locality is at 8500′, in the Myitkyina District, but Mayr when describing this races clearly states that birds from Htawgaw, in the north of the same district, are nominate *erythrocephalus.* In the description, the bird is compared with *yamakanensis* Rickett (Yamaken, Fokkien) specimens of which are not available for comparison.

715 **Harpactes erythrocephalus erythrocephalus** (Gould) (Rangoon)
East Bengal Redheaded Trogon **4**: 318

6 : 3 ♂♂ (1 by plumage) 3 ♀♀

1 *Mogok Rd., Ruby Mines*; 1 *N. Shan States*; 1 *Nyaunggyo, Myingyan Dist.*; 2 *Prome Dist.*, 1 *Legongyi, Henzada Dist., Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	143, 145(2)	19(2), 20	18(3)	175, 180, 183
♀♀	146, 147, 150	18, 19, 20	17, 18, 19	175, 184, 185
	(IH 143-148	from skull 21-22	—	177-201)

Except for a male from Legongyi, Henzada District, the others are pink rather than red below. The males show a lot of grey on the head and the upperparts are slightly less rufous than in *helenae.*

716 **Harpactes wardi** (Kinnear) (Seingkhu Valley, 8000 ft., Burma)
Ward's Trogon

nil.

(to be continued)

Six new Taxa of Flacourtiaceae from India and Burma

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(*With a text-figure*)

INTRODUCTION

In course of the revision of the family Flacourtiaceae of India, Burma and Ceylon the author noted a number of interesting herbarium sheets at Central National Herbarium, Botanical Survey of India, Calcutta (CAL), Herbarium of Forest Research Institute, Dehra Dun (DD), Herbarium of Southern Circle, B.S.I., Coimbatore (MH) and Herbarium of Eastern Circle, B.S.I., Assam (ASSAM), some of which form the basis of the present paper.

Homalium ciliatum sp. nov.

H. ciliatum Debb. in Kanjilal and Das, Fl. Assam 1 : pt. 2 (i) 1934-*nomen.*

Affinis *H. bhamoense* Cubitt et Smith sed foliis subcoriaceis, acutis ad basin, acuminatis ad apicem; inflorescentis ad 10 cm longis; flores in glomerulis 5-8 floris inter alia differt.

Typus lectus a U. N. Kanjilal in montibus Garo in Assamia die 4 martii 1931 et positus in ASSAM sub numero 5221.

Tall tree ; bark ashy-grey, outside fairly plain, inside dun-brown, rather coarsely granular ; branches horizontal, covered with white hairs ; branchlets with white lenticel. *Leaf* oblong-lanceolate, margin distantly crenate, upper surface glabrous, lower surface pubescent, base acute, apex acuminate, lateral nerves 8-9 pairs, veins not prominent above, subcoriaceous, 8-12·50 cm by 4·20-5 cm, petiole 5-8 mm long, puberulous, *Inflorescence* axillary raceme, drooping, puberulous, up to 10 cm long. *Flower* in 5-8-flowered glomerules, 2·5-mm long ; pedicel 1·5 mm long, puberulous. *Sepals* 6-7, in turbinate tube, 1 mm long minutely hairy outside, linear, margin ciliate. *Petals* same as sepal but slightly larger and oblong. *Stamens* 6-7, one opposite each petal and exceeding them in length, filament filiform, glabrous, anther oblong short; staminodes alternating with stamens, much shorter, hairy. *Ovary* half-inferior, free portion hairy, ovate, one-chambered; styles mostly 4, filiform, forming a crown at the top of the ovary.

Assam: Garo hill, near mile post no. 11 *Kanjilal* 5221 (ASSAM).

This species is nearest to *H. bhamoense* Cubilt et Smith, but it differs from the latter in having subcoriaceous leaf with acute base and acuminate apex; inflorescence up to 10 cm long; flowers in 5-8 flowered glomerules. It was named as *H. ciliatum* Debb., but was never described.

Scolopia burmanica sp. nov.

Text-fig.

Affinis *S. kermodei* Fischer sed foliis coriaceis, oblongolanceolatis, breviter acuminatis ad apicem; filamentis 8-10 mm longis, antheris linearibus; floribus in inflorescentis laxis; fructu globosis inter alia differt.

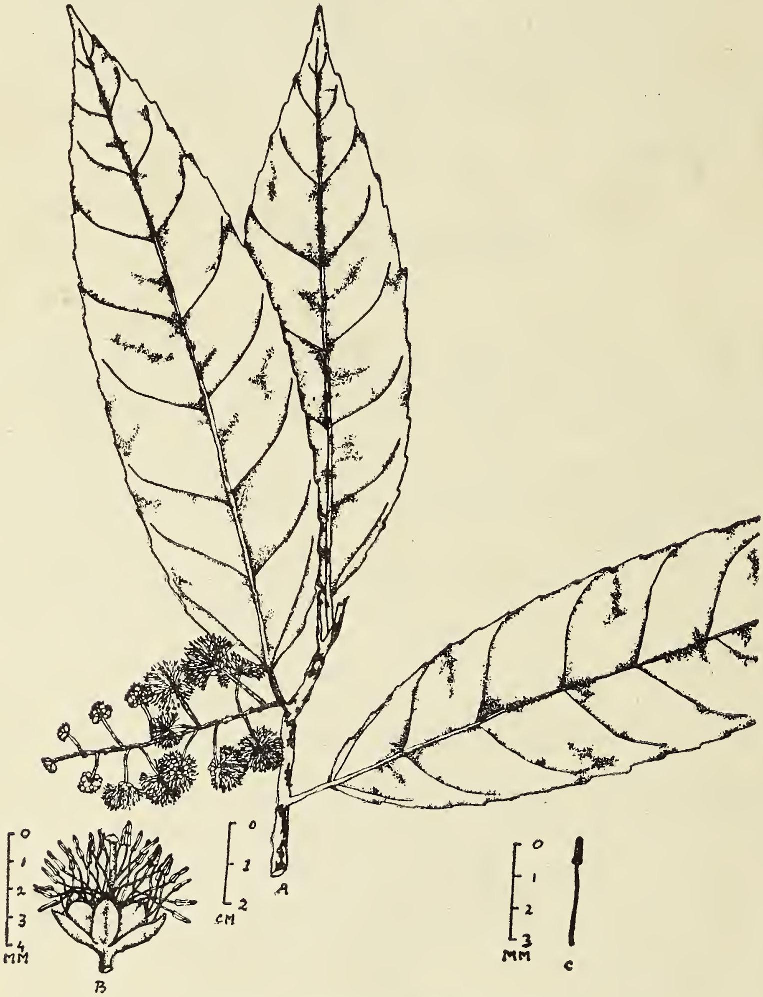
Typus lectus a Mg Ba Pe in via Prome prope Rangoon in Birmania die 11-2-1932 et positus in herbario instituti Forestalis ad Dehra Dun subnumero 13080.

Tree 9-14 m high, stem spinous, spines 2-3 cm long. *Leaf* oblong-lanceolate, coriaceous, lower surface glabrous, upper surface glaucous, apex shortly acuminate, base acute, distantly serrate, 15·50-20·20 cm by 3·60-5·60 cm; 8-9 pairs of lateral nerves, reticulations not so prominent; petiole 9-12 mm long, with a pair of glands at the apex. *Inflorescence* axillary raceme, 4-6 cm long. *Flower* white, 4-8 mm diameter; pedicel articulated, 12-18 mm long, glabrous. *Sepals* 8, lanceolate, glabrous with ciliate margin, fleshy, 2 mm long, connate at the base. *Petals* 8, same as sepal but a little broader. *Stamens* many, filament 6-9 long, glabrous, anther linear, 1·5-2 mm long, with glabrous connective; disc-gland thick. *Ovary* ovoid, style 4 mm long, stigma flat with crenate margin. *Fruit* globose, 2·5 cm diam., smooth with persistent sepal and style.

Fl.-Feb. Fr.-May.

Lower Burma: Prome Rd., Rangoon *Mg Ba Pe* 13080 (DD); Prome Rd., Rangoon *Parkinson* 14431 (DD).

I found two herbarium sheets within the lot of sheets of *S. spinosa* (Roxb.) Warb. in the herbarium of F.R.I., Dehra Dun; one of which was sent to the Kew herbarium for identification where it was remarked that it was not *S. spinosa*. The specimen differs from *S. spinosa* in having eight glabrous sepals, glabrous connective of anther and larger leaf with serrate margin. It differs also from *S. kermodei* Fischer in having globose fruit; coriaceous, oblong-lanceolate leaf, 8-10 mm long filament of stamen, linear anther. The characters shown in the present report are distinctive and justify the creation of new species.



Text-fig. *Scolopia burmanica* sp. nov.

A. A twig with inflorescence ; B. A flower ; C. A stamen.

Casearia sikkimensis sp. nov.

Affinis *C. graveolens* Dalz. sed foliis membranaceis, marginibus distanter serratis, pedicellis non-articulatis, palum pilosis, staminodis filiformibus, filamento aequilongis ; fructu globosis inter alia differt.

Typus lectus a J. S. Gamble in Dhobijhua ad Kurseong mense aprili anni 1882 et positus in CAL subnumero 10316.

Large tree ; branches glabrous ; bark lenticellate. *Leaf* lanceolate or oblong-lanceolate, distantly serrate or entire, apex shortly acuminate, base acute sometimes cuneate, membraneous, glabrous, 5-7 pairs of lateral nerves, slightly oblique, reticulations not so prominent, 5·60-12·50 cm by 2·51-4·71 cm, stipule early caducous ; petiole 0·6-1·2 cm long, glabrous. *Flower* in axillary cluster, much crowded ; 1·5 mm diam., glabrous ; pedicel slightly hairy, 5-8 mm long, not articulated at the base ; bract 1 mm long, ovate, laxly pilose. *Sepals* 5, almost ovate, apex acute, 2·5 mm long, outer surface tomentose, inner glabrous, margin ciliate. *Stamens* 7-8, slightly united at the base, filament hairy, 2 mm. long, anther ovate, basifixed, staminode filiform, slightly narrowed to the apex, hairy, equal in length to the filament. *Ovary* conical, glabrous, 1 mm long, 1-2 ovules on each placenta ; style 0·5 mm long, stigma discoid. *Fruit* globular, 8-10 mm diam. ; seeds 3-4, ovate and slightly compressed.

Fl.-Apr. Fr.-Oct.

Bengal : Dhobijhua 6000′, Kurseong *Gamble* (CAL), 10316 Sepoydura 5000′, Darjeeling *Gamble* 6875 (DD) ; Rangirum 6000′, Darjeeling *Gamble* 6881*C* (DD) ; Sikkim, without locality *King* 944 (CAL) ; Mahalderum 2500′, Sikkim *Anderson* 66 (CAL) ; Tongloo 6000′, Sikkim *Kurz* (CAL) ; Assam : Naga Hill *Bor* 20873 (ASSAM) ; Dumlep forest, Khasi Hill *DAS* 10208 (ASSAM).

There are two specimens in Central National Herbarium, collected by Gamble from Dhobijhua, Kurseong, and identified up to genus *Casearia*. There are some other specimens and all these specimens are kept with *C. tomentosa* Roxb. as being similar to the latter. But critical examination shows that the former specimens differ from Roxburgh's species in having smaller leaves, lesser number of lateral nerves, non-articulated pedicel, filiform staminode and globular fruit. On the other hand, this species has got some similarity with *C. graveolens* Dalz., but the lanceolate, membraneous leaf, acute leaf base, globular fruit favours separation of the former from the latter as a new species.

Casearia rubescens Dalz. var. **gamblei** var. nov.

Foliis late lanceolatis, ad apicem acuminatis, nervis lateralibus 9-11 jugis.

Typus lectus a T. F. Bourdillon ad Peermerd et positus in CAL subnumero 181.

South India: Evergreen forest of Pirmed 3500′ *Bourdillon* 181 (CAL) ; North Canara without locality *T. R. Bell* 6013 (CAL).

This variety differs from the type variety, *C. rubescens* Dalz. var. *rubescens* in having broadly lanceolate leaf, acuminate apex and 9-11 pairs of lateral nerves. The type variety has ovate-oblong leaf, obtusely acuminate apex and 6-8 pairs of lateral nerves. Gamble (1920) remarked 'this specimen collected by Bourdillon No. 181 from evergreen forests at Peermerd, which, I think is a form of *C. rubescens* Dalz. with more lanceolate leaves than the Bombay plant.' A critical examination shows that it differs from the type variety in other characters and deserves separation as a new variety.

Scolopia crenata (Wight) Clos var. **brevifolia** var. nov.

Foliis 4-8 cm longis et 1·5-2 cm latis, hand obliquis ad basin, pedicellis brevibus, 2 mm longis.

Typus lectus a Sebastine ad Courtallum in Tinnevelly et positus in MH subnumero 5881.

South India: Tinnevelly dist., Courtallum *Sebastine* 5881 (MH); Trichinopoly, Salur to Vallarum *Subramanium* 13031 (MH).

This variety differs from the type variety, *S. crenata* (Wight) Clos var. *crenata* in having leaf up to 8 cm long and 2 cm broad, leaf base being not oblique and short pedicel, 2 mm long. The type variety has leaf 9-15·50 cm by 2·50-6·30 cm; oblique base; pedicel 4-6 mm long. The specimens have been compared with the photograph of the type of *S. crenata* (Wight) Clos received from Kew herbarium.

Hydnocarpus kurzii (King) Warb. spp. **australis** Sleum. forma **latifolia** forma nov.

Foliis multo latis, 9·20 cm breviter accuminatis ad apicem.

Typus lectus a S. Kurz ad Pegu in Birmania et positus in CAL subnumero 532.

Lower Burma: Pegu without locality *Kurz* 532 (CAL); Waykon steam, Mawlaik *J. chin* 51. *B.I.* (DD).

This form differs from *H. kurzii* (King) Warb. spp. *australis* Sleum. in having broader leaf, more than 9·00 cm. The breadth of the leaf of the sub-species has been found to be up to 8·00 cm. So this single character variant has been given the rank of forma.

ACKNOWLEDGEMENTS

I am grateful to Dr. S. K. Mukherjee, Ex-Keeper, Central National Herbarium, B.S.I., Calcutta, for his assistance in the preparation of this paper and to the Late Rev. Father Dr. H. Santapau, S.J., Ex-Director, Botanical Survey of India, Calcutta, for the Latin diagnosis.

Obituary

Lt. Gen. Sir HAROLD WILLIAMS

(1897-1971)

Lt. Gen. Sir Harold Williams KBE, CB, CBE, MICE, MIS (Ind.), MIE, passed away in Mussoorie on the evening of 17th October, 1971. Earlier the same day he had been viewing the Bunder Punch and Gangotri Ranges from Camel's back and reminiscing with a friend about his last visit to these particular mountains. On the 18th October he was buried within sight of the Himalayas at his beloved Roorkee, where he had a spent so many happy and rewarding years.

Those not familiar with Gen. Williams' long and meritorious service as a Sapper will be interested in a résumé of his professional career. He was born in 1897 and, after leaving school, entered the Royal Military Academy at Woolwich during World War I. Commissioned as a Second Lieutenant in the Royal Engineers in 1917, he was posted a year later to the Bengal Sappers and Miners at Roorkee. He was sent up to Cambridge (Gonville & Caius College) in the early 1920's, where I first met him. In 1929 he became the Adjutant and later commanded the Bengal Sappers & Miners. He was the first R. E. Instructor at the newly formed Indian Military Academy at Dehra Dun, where most of the present ' top brass ' of the Indian Army passed through his hands at one time or another. His next assignment was a return to Roorkee again, this time as Professor of Civil Engineering at the Thomson College, where he stayed from 1936-1938. He served during the Second World War in France and in Burma and Assam. After the war, he became the Commandant of the New College of Military Engineering in 1945, a post he held until his appointment as Engineer-in-chief of the Indian Army in 1948. Bill was E.-in-C. for seven crucial years, until 1955, and his tenure in this key post will long be remembered.

On retirement from Military service, he took over as the first Director of the Central Building Research Institute (CBRI) at Roorkee, having been associated with its formation earlier as the Chairman of the Building Research Committee. During the next six years, as Director CBRI, he extended the scope of building Research in several practical directions with such excellent results that when his tenure with CBRI expired he was intensively used by both the CSIR and the Planning Commission, from 1962 to 1967, as a top level consultant and left his mark on many projects.

In addition to his official career, Bill's tireless energy and wide range of interests were also connected with a number of engineering organisations to whose advancement he contributed much throughout the post-war period. He was closely associated with technical education and was connected with several universities in India in addition to being a member of many scientific committees.

Bill loved nature in all its several manifestations and was full of the milk of human kindness in his understanding and sympathy with other naturalists, specially of the younger generation. He could always be counted upon by mountaineers, ornithologists, and lovers of Wildlife for encouragement and whole-hearted support.

Along with Horace Alexander and Sálim Ali he was largely responsible for saving the Keoladeo Ghana as a waterfowl resort from imminent destruction by the Rajasthan Government soon after the merger of Bharatpur State, through the personal interest and good offices of the then Prime Minister Jawaharlal Nehru.

From his own ancedotes, supplemented by exchanges with his friends, it is clear that Gen. Williams spent a great deal of his Indian leaves enjoying treks in the Himalayas and also an appreciable number of his duty tours, particularly after 1950, among the higher hills. The surveys and the constructions of many of the first lines of jeepable roads that replaced old bridle paths, going over passes into the 'inner circle', where his 'babies' while he was E.-in-C. He is estimated to have visited these mountains on about a hundred occasions and this made him fairly familiar with the entire range between the Indus and the Brahmaputra, as well as most of its fauna, in which he was always interested.

He was President of the Himalayan Club during 1960-63 and had previously served on its Committee in other capacities. It is estimated that he was personally known to more than 300 of the 650 odd members of the club, spread over 40 different countries.

Another strong link between him and Indian youth during the post-war period was his very keen interest in Bird Watching and in the study of Wildlife. The writer observed him, in the early 1950's, provide the guiding force behind the formation of the Delhi Bird Watching Society and later organise the field excursions and personally arrange for the publication of field check-lists would appeal to the largest number of young Naturalists. He donated generously to such activities and provided hospitality to visiting experts invited to give illustrated talks in Delhi to beginners. Along with the writer, he represented the Bombay Natural History Society in Delhi for several years and fought its battles with persistence and knowledge.

He was also a keen Freemason and made several All India tours, between 1968 and 1971, in connection with furthering its activities.

His outstanding efforts were widely appreciated and he was awarded a CBE in 1946, followed by a CB in 1962. He read a great deal in spite of other demands on his time and was most generous in donating his books to libraries. To us, who knew him over half a century, Bill Williams represented a vintage that is now getting rare. There was more than physical achievement in the results he obtained ; there was a mellowness in his dealings with organisations and a warmth in his contacts with individuals that will linger in memory.

F. C. BADHWAR

Reviews

1. THE COMPLEAT NATURALIST : A LIFE OF LINNAEUS. By Wilfrid Blunt, with the assistance of William T. Stearn. pp. 256 (24·5×19 cm). Numerous illustrations, in colour and monochrome. London, 1971. Collins. Price $14·95.

To most persons, even to some who profess to be scientists, Linnaeus is merely a name, the father of the binomial system of scientific nomenclature, the propounder of a system of classification of the Animal, Vegetable, and Mineral Kingdoms which in time replaced the previously accepted systems, an author who has described and named numerous plant and animal genera and species. This eminently readable biography of that great man, profusely illustrated with aptly chosen and well reproduced illustrations, is therefore very welcome.

Little Carl imbibed his love of plants at an early age from his father, a Lutheran curate at Stenbrohult in southern Sweden, and as a child had his own little patch of garden to look after. He devoted his energies to his hobby in school at Växjö, where his parents supposed him to be preparing to follow in his father's footsteps ; so much so that, his teachers finally pronounced him fit only for manual work, a carpenter or a tailor perhaps ! But a local doctor saw the promise in the boy, and took him under his wing during the last year of his school-life and introduced him to a serious study of botany and physiology. At both the Universities which he attended, Lund and Uppsala, the teaching was unsatisfactory in the faculties with which he was concerned. He must have had something very impressive about him, however, because at both places he found patrons who helped with his education and housed and fed him during his stay there.

He made his mark when he was only twenty two with a thesis, *Praeludia*, *Sponsaliarum*, *Plantarum*, presented to his patron at Uppsala, Dr. Olof Celsius, in lieu of the verses customarily presented by pupils to their teachers on New Year's Day—' I am no poet, but something, however, of a botanist ; I therefore offer to you this fruit from the little crop that God has granted me ', he tells Dr. Celsius in his foreword ! In the thesis he discussed the functions of the stamens and pistils in plants and likened them to sex in animals. Possibly as a result of this, while he was still a second-year student, he was entrusted with botanical demonstrations to other students during temporary absences of his Professor from Uppsala.

At twenty-five years of age he undertook his first extensive collecting expedition, lasting about four months, through Lapland starting from Uppsala round the northern end of the Gulf of Bothnia and then back home across the Gulf. Plants, animals, minerals, local ways and manners, customs and beliefs, everything was carefully entered in his notebook with sketches where necessary and specimens were collected. Already at that early age his system of classifying quadrupeds was germinating in his mind and the sight of a horse's lower jaw prompted a note : ' If only I knew how many teeth and of what kind every animal had, how many teats and where they were placed, I should perhaps be able to work out a perfectly natural system for the arrangement of all quadrupeds '. There was yet another collecting trip, to the Province of Dalecarlia, in the company of seven fellow students, before he left Uppsala to pursue his studies abroad. Several more collecting expeditions were to follow in later life, the last one undertaken at the insistence of the King of Sweden although Linnaeus, then only forty-one, pleaded that he was physically worn out, a plea that he could justifiably put forward in view of the very little rest he had allowed himself throughout his life.

Linnaeus was well received in scientific circles abroad, wherever he went. In Holland Johan Gronovius the Younger and a young Scots doctor studying at Leyden showed their appreciation of his *Systema Naturae*, outlining his system of classification of the three Kingdoms, by getting the manuscript printed at their own expense. Booerhaave attempted to persuade him to make his career in Holland, holding out as an inducement the possibility of a professorship at Leyden. His experience with Dillenius at Oxford is interesting. At their first meeting he caught Dillenius's remark to a companion : 'This is the man who has thrown all botany into confusion'. Two days later he asked Dillenius why he had said this. I continue in the words of Linnaeus :

> ' . . . he said, " Follow me, and I will show you ". When we reached his library he produced my *Genera Plantarum* . . . I saw that he had written " N.B." on almost every page. " What does that mean ? " I cried. " Each N.B.", he said, " means a false genus".'

One of the disputed flowers, a *Blitum*, described by Dillenius and other botanists as having three stamens, was brought from the Garden. I let Linnaeus continue :

> ' I opened the flower and showed him that it had only one. " No doubt it's an abnormal specimen ", he said. We opened several more, and they were all the same. We passed on to several other genera, and all tallied with my description of them. Dillenius was amazed and said, " I shall not let you leave ". He kept me a month, and gave me all the live plants that I wanted for Clifford '.

On his return to Sweden, at the age of thirty-one, he set up as a practising doctor at Stockholm in order to satisfy his prospective father-in-law, who insisted that he must have a regular source of income before he married. To begin with patients were few, but a lucky success with a young *roué* suffering from gonorrhoea brought him a flourishing practice in fashionable circles, and in time he found himself in the position of Physician to the Admiralty. In spite of the big income, however, his heart was not in the work and, three years later, he joyfully accepted a professorship at Uppsala, a post he retained for the rest of his life.

As a professor he was a great success. His lectures were often so crowded that latecomers had to hear what they could from the entrance hall and corridors. Botanical excursions were gala occasions. This is a description by one of his pupils:

> ' The cheerful party—there were often a hundred and fifty of us of various nationalities . . . broke up into small groups who had orders to forgather at an agreed hour ; Linnaeus kept with him only a handful of the cleverest students. Sometimes the rendezvous chosen was the Castle of Säfja, and we would all set out in that direction, not without a lot of hilarity which Linnaeus never attempted to restrain. As soon as everyone had assembled, Linnaeus began to identify the plants which had been collected. A table was spread for twenty, provided with fruit and syllabubs, and those who had found the rarest plants sat with the Master at this table ; the rest ate standing up, hoping one day to enjoy the honour all envied and which was enough to stimulate the most lively competition among these young rivals '.

The book is not all praise for this great man. Like other human beings, Linnaeus had his faults and his little peculiarities and failings. The author does not avoid telling us about them. Altogether, the picture he paints is that of a very human, lovable man.

In an appendix Mr. William T. Stearn explains the Linnaeus classification, nomenclature, and method. The book concludes with a short bibliography, a list of the principal works of Linnaeus published in his life-time, and an index.

D. E. R.

2. HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN. Vol. 6. By Sálim Ali and S. Dillon Ripley. pp. xvi+245 (24×16 cm) with 8 coloured plates and numerous black-and-white illustrations. Bombay, 1971. Oxford University Press. Rs. 90.00.

This sixth volume of the ambitious project of the 10-volume HANDBOOK contains accounts of 209 species and subspecies of passerine birds covering Cuckoo-Shrikes (Campephagidae) to Babaxes (Muscicapidae, Timaliinae, part). The distribution maps in the present volume are a distinct improvement over those in the previous volumes in that there are few, if any, discrepancies between the text and maps. As in earlier volumes, page references in many of the Keys to species and subspecies appear to have been inadvertently left out in the present volume. Bhutan has been included in the range of *Chrysomma altirostre griseigularis* (Hume) (p. 194), presumably based on ' Bhutan Duars ' of Baker (1922, FAUNA BR. INDIA, *Birds,* **1** : 236). In point of fact, however, this bird has never been reported from Bhutan, although it is quite likely to occur there. ' Bhutan Duars ' is a tract of country about 290 km long and 32-48 km wide, lying along the foot of the Himalayas, that was ceded to British India by Bhutan after the Bhutan War in 1865. Its western portion lies in the Jalpaiguri district of West Bengal and forms the major part of 'north Bengal duars ', while the eastern portion lies in the Goalpara district of Assam.

The high standard of the previous volumes is well maintained both in the text and the coloured plates, except plate 71 (facing p. 192) where mounted birds seem depicted.

BISWAMOY BISWAS

3. CHALLENGE TO SURVIVAL. By Leonard Williams. pp. 316 (14×22 cm). 12 pp. of photographs. London, 1971. André Deutsch Ltd. Price £3.50.

In this introduction the author says : ' This book is not a survey of the destructive features of our modern society. It takes those features for granted. The project is more ambitious : it seeks to disclose the moral dynamics of the nature of man, to define that nature and its origin in prehistory, and to point the direction I believe the human species must now take if it is to survive'.

The author established a colony of woolly monkeys (*Lagothrix lagotricha*) in southwestern England more than ten years ago, and six babies have been born there since 1965. This Julian Huxley has described as ' almost a miracle ' and a great triumph for Williams's method of studying and caring for these ' wonderful animals '. The colony has been described in previous books by the author and this one begins with an extract from a description of the ' friendship ceremony ' performed with the dominant-male monkey Jojo : ' I adopt a submissive attitude, with hand and arm shielding my face, and crawl towards him sideways, *tuff-tuffing* all the way ' ; yet eight pages later the statement is made that adult and juvenile monkeys ' do not head-shake or *tuff-tuff* in any of their friendship greetings or gestures of appeasement '. It is difficult to reconcile the two statements, or to understand a sentence such as this from p. 268 : ' Somewhere a government of the people must take ethico-political action in the interests of human survival, regardless of whether it is interpreting the majority-will of its own people or not'. Here 'People' must have two different meanings in the same sentence.

The main argument of the book appears similarly stultified. On the one hand there are vigorous attacks on the 'dramatic fictions' (p. 61) of Robert Ardrey and other writers who maintain that much of man's present activity is traceable to instincts or drives that have been inherited, and on the other reliance is placed on the corrective power of another inherited drive which is called 'instinctual morality'. On p. 137 the author refers to 'an instinctual morality for mutual co-operation' which is 'a social instinct that is fundamental in all primate societies' and which he regards as 'a biological premorality' (p. 159). The most weighty evidence adduced in support of this instinctual morality seems to be Jojo's behaviour when the woolly monkeys had been given access to a new area. For three days Jojo kept all other members of the colony away while he made the trees safe for them. His behaviour is described as follows (p. 274) : 'When he sped across the ropes to the first tree, he paused on a high branch and peered in all directions. There was no swinging, leaping or running—no random behaviour of any kind. A swinging action was used only when he hung by the tail to test the lower branches with his hands. Dead wood and old branches were broken off and dropped to the ground. Gradually his passage through the trees expressed a definite pattern. Alternative routes were examined with caution until, stage by stage, he learned the whole tree. He was considering the prospects of adding a new area to an established territory. For two days a small group of beech trees was investigated in this way, and not one monkey in the colony was allowed to share in the exercise'. It would be interesting to know whether such precautionary and responsible foresight has been observed among gorillas and chimpanzees, who evolved much later than the woolly monkeys.

When describing his monkeys the author is fascinating, but most of the book is exceedingly hard going, demanding familiarity (which this reviewer lacks) with the literature of evolution, palaeontology, ethology, anthropology, Marx, Engels and Levi-Strauss. A single example must suffice : 'There can be no doubt that the dialectic of Levi-Strauss affirms the unity of historical and prehistorical humanity. This unity, however, recoils from the obligation to affirm a self-identity of history and dialectic reason, in short—it fails to declare itself as a *universal dialectic*' (p. 251, author's emphasis).

The challenge to survival, as the author sees it, is summarized in this passage (pp. 127-8) : 'The tragedy of our own time is not only the ecological crisis that threatens to destroy us, but the possibility that man will succeed in adapting to an automated existence, to an amoralized and electronic environment of industrial noise, synthetic food and polluted air and water ; to an anti-culture that exiles all the spiritual, aesthetic and biological impulses that constitute the very drive and fabric of human nature. In such an environment words like humanity, beauty, kinship, love and art have no meaning'. As immediate responses he would advocate living in groups rather than pairs, splitting large and powerful nations into small, weak states, and a creative rather than acquisitive approach to living ; but as a solution what the author hopes for is (pp. 104-5) ' a rapid and subtle mutation in the human psyche that matches the explosive tempo of a nuclear society, a society unparalleled in history for its rapid accumulation of destructive power '. ' Faced by such a devastating challenge ', he says, ' new and revolutionary insights may well become fixed in the instinctual machinery of a new morality, and for all we know such mutations and genetic recombinations have already occurred '.

R. E. H.

4. UGANDA QUEST. By Ernest Neal. pp. 128 (17×24·5 cm). With 44 coloured illustrations. London, 1971. Collins. Price £2·25 net.

The Author who is Head of the Science Department at Taunton School, was invited by the Nuffield Unit of Tropical Animal Ecology to spend a few months in the Queen Elizabeth National Park, Uganda, to study the middle-sized carnivores like hyenas, genets, civets, servals and mongooses (of which there were five species in the park) about whose ecology virtually nothing was known.

Neal and his wife spend four months from the end of 1968 on this assignment and the Author says that he did not expect he could do more, in the short time at his disposal, than to initiate a line of research. The book refers to some investigations of the Banded Mongooses ; their dens, social unit, play, reproduction etc.

The dens are termite mounds, occasionally burrows dug into erosion gullies. The site is usually on elevated ground affording a good view of surrounding land, with bushy vegetation around.

The social unit consists of twenty to thirty individuals, about half of them adult. Their food is mainly coleopterous (beetles, millipedes and ants). The mongooses are promiscuous. Mothers suckle not only their own young but also the young of others. They also apparently take turns to baby-sit while the rest of the adults go out foraging.

The observations on the Banded Mongoose take up the latter third of the book, the earlier part being devoted to a general description of the Park's ecology and the various animals which the Neals encountered on their nocturnal excursions in a Land-Rover with a spot light. These included lions, elephants, hippos, buffalo, chimpanzees and the Giant forest hog. There is an interesting account of a lame lion that had been permitted a hanger-on's status in a pride of lions and depended for his food on their kills.

The book would have been more readable if it had been written with more verve. Some descriptions could certainly have been improved, e.g. p. 20 referring to a hippo, '... like a huge pinkish-brown cylinder motivated by short fast moving legs; the other two followed after'. There are 44 colour photographs of birds, animals and insects, some of which are quite good.

G. S. RANGANATHAN

5. THE ADAPTIVE GEOMETRY OF TREES. By Henry S. Horn. pp. 144 (21.5 × 14 cm). Princeton, New Jersey, 1971. Princeton University Press. Price $7·95.

In this book the author investigates the problem of succession in a forest. Adopting a simple measure of the intensity of light in the understory, he builds up his theory point by point: why does succession occur, how is the order of succession determined, what is the strategy employed by different species in the competition for light, how do the distribution, size, and shape of the leaves affect the place of a species in the succession, why do the species that dominate in the climax not dominate in the early stages of succession, and connected problems that suggest themselves. The predictions based on theory are verified by observation in woods and forests. It is fascinating to follow the arguments as they lead by logical steps to the author's conclusions. Though the average reader will find the mathematical reasoning in the later chapters difficult to follow, he will feel rewarded for the effort by the new light it sheds on his knowledge of trees.

D. E. R.

6. THE SOCIAL IMPACT OF MODERN BIOLOGY. Edited by Watson Fuller. pp. viii+256 (17·5 × 11 cm). London, 1971. Routledge & Kegan Paul. Price 50 p. net.

In November 1970 a conference organized by the British Society for Social Responsibility in Science was attended by about 800 people from all walks of life, and this book contains edited versions of nineteen papers delivered at the conference with a selection of the discussion arising out of each and a final summing-up by M. H. F. Wilkins.

The papers have been grouped in six sections entitled (1) Science, technology and values, (2) Molecular genetics, (3) Human genetics and reproduction, (4) Immunology and cancer, (5) Agricultural botany and the environment, and (6) Science in Society. The two papers dealing with the double-helix arrangement of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) by W. Hayes and M. R. Pollock, both of Edinburgh, reveal the revolutionary character of recent biological studies. Hayes says (p. 58) : ' molecular biology has clearly shown that the phenomena of life at the cellular level can be entirely and exclusively accounted for by the known behaviour and interactions of molecules, so that vitalistic ideas, so prevalent until recently, have become irrelevant and unnecessary '. The immensely long stretches of DNA (two metres in the chromosome of a mouse cell) can be divided into coherent stretches or genes (combinations of the four bases A, T, C, and G, adenine, thymine, cytosine and guanine) which in a suitable environment promote a particular chemical reaction (such as one step in the chain of reactions for the oxidation of glucose) or determine the rate at which such a reaction takes place.

Some of the ways in which this knowledge may be applied to change plant and animal life are considered by the other speakers. The possible applications are so varied and extensive that some of them suggest scientists should stop working for a society that misdirects them and misapplies their discoveries. It appears however that the rate of discovery is not diminishing and that the patterns of human life will change rapidly within the next few decades. For example (pp. 154-5) : ' Improvements in our understanding of factors controlling crop production are absolutely essential if we are to avoid a catastrophe stemming from widespread starvation. It goes without saying that no increase in food productivity alone can solve this problem, which must ultimately be linked to stabilization of the world's population through the co-operative action of all governments'.

R. E. H.

7. INDIA—THE LAND AND PEOPLE—INSECTS. By M. S. Mani. pp. v+133 (14×20 cm). 14 line drawings. 18 plates, black and white and in colour. New Delhi, November 1971. National Book Trust, India. Price Rs. 5.25.

For a long time there has been a need for a low-priced popular book to serve the layman as a guide to the abundant insect life of our country. The publication of this book by the National Book Trust is therefore welcome. It contains chapters introducing many of the insects the average reader is likely to encounter in the garden, the home, inland waters, &c. and includes information about their habits and behaviour. As one would expect there is an excellent chapter on insects of the Himalaya. This is exactly what was needed. However, it must be pointed out that there are a number of faults which can be rectified in future editions.

There are many plates and figures, which are a must in a book like this. Most of the photographs were presumably taken by the author and his colleagues (there is no indication who the ' we ' of the preface may be). Most of the coloured plates are so blurred in reproduction as to be virtually useless. In plate XVI the ladybird beetle *Epilachna* sp. seems to be blue, whereas on p. 66 we are told it is reddish-brown. It might be better to have clear coloured drawings, like those on the cover. It would also be useful if there were a bibliography, as there is in some other books published by the National Book Trust, so that a reader wishing to become further acquainted with the Insects knows where to look for information.

Butterflies and moths are among the most noticeable of insects, and they have rightly been given a chapter to themselves. The commonest species have a line or two of description so that they can be identified, but some of the descriptions could be improved on. For instance, can *Acherontia styx* the common Death's Head Moth be described as ' reddish coloured ' ? *Delias eucharis* is described as ' about 8 cm large (*sic*) white with black lines '. Mention of the red and yellow markings would have made this butterfly instantly recognizable. Among the Papilios descriptions of the common *Papilio demoleus* and the red-bodied and black-bodied swallowtails would have been more useful than that of the more spectacular but less common *Troides helena.* Again, we are told that Amathusids are among the common butterflies of India, but the only one named is *Discophora lepida* described as ' a rare, large-sized dark brown butterfly, with bluish white spots '. The Hesperids have been left out, though mentioned among the common families.

The facetious anthropomorphic tone adopted from time to time is misleading and out of place in a book like this. For instance, in the chapter entitled ' Child Welfare in Insects ' which contains a great deal of interesting information, we are told : ' The female is essentially a mother, not a wife ' and the author goes on to generalize about human behaviour. This is simply meaningless in an age when it has been recognized that great caution must be exercised in drawing conclusions about human behaviour from that of even our closest living relatives, the apes.

It is also unfortunate that the only reference to the great French entomologist Fabre should be a slighting one. Fabre was the first person to study the behaviour of insects and was ahead of his time in adopting an experimental approach to it. It was he who first observed the behaviour of the dung-beetle, which is illustrated in figs. 10-12. If some of his conclusions were wrong it is scarcely surprising given the rudimentary state of the science of behaviour in his time. Moreover, Professor Mani is on shaky ground when he argues on p. 52 that since the results of his experiments with the mud wasp *Eumenes* were different from the results of Fabre's experiments with an altogether different species, *Chalcodoma* the mason-bee, Fabre was wrong. In another experiment Fabre found that the young mason-bee would bore through a clay barrier but not through a paper barrier beyond it, which he construed to mean that its instinct was only to bore through one barrier. Professor Mani found that the young mason-*wasp* would cut through three clay barriers, and says that this means that clay is within the experience of mason-bees and mason-wasps and that paper is not. Neither Fabre's conclusion nor Professor Mani's seems justified without further experimentation.

Professor Mani's argument is that insects are capable of more intelligent behaviour than orthodox scientists give them credit for. There is indeed evidence that insects are capable of intelligent behaviour and even of learning [see J. D. Carthy (1965) : THE BEHAVIOUR OF ARTHROPODS, reviewed in this Journal at p. 423, Vol. 63], but Professor Mani's examples are not conclusive. The seemingly intelligent behaviour of the wasps he describes may be the result of their reacting to different stimuli from those to which the mason-bee studied by Fabre reacted. Similarly, the digger wasp which refused crickets which were offered outside their burrows because it ' knew ' that it could not drag them to cover might simply not have reacted because the situation lacked one of the appropriate stimuli required to release hunting behaviour.

The final chapter of the book draws up a balance-sheet. It is to be hoped that many readers will be impressed by the beneficial activities of insect predators and parasites of insect pests and by the role insects play in pollination, and that it will help to bring about an awareness of the dangers of the indiscriminate use of insecticides.

R. R.

8. THE WHALE. Edited by Leonard Harrison Mathews. pp. 287 (27 × 25 cm) with many illustrations. London, 1968. George Allen & Unwin. Price $5.25.

There are many tales about cetaceans (whales, dolphins and porpoises) in the mythology and folklore of the Romans, Scandinavians, Icelandic and other people. These describe creatures both gentle and malevolent.

Pliny refers to a dolphin during the time of Augustus Caesar which developed a great affection for a young boy and carried him to school and back home across a bay and when the boy fell sick and died, the dolphin too died of grief.

Pelorus Jack was the name given to a friendly dolphin that lived near Pelorus Sound at the north end of South Island, New Zealand, for over twenty years, which met and escorted every ship sailing between Nelson and Wellington. He became so famous that in 1904 a law was made to protect him from molestation. Unfortunately, in 1912 he is supposed to have been killed by the crew of a Norwegian whales.

In Brazil, the river dolphins called botos or bufos are sacred to the Amazon dwellers, as cows are to Hindus. In Vietnam too, the people treat the whale with affectionate respect and perform funeral ceremonies for any found dead. And on Seikai-to Island off the Coast of Western Japan there is a Buddhist temple called Koganji where a requiem has been held since 1679 for the repose of the souls of whales killed by Japanese net-whalers. Posthumous Buddhist names are given to the whales.

Man's use of whales stranded on their shores led to their being hunted for the meat they provided and the oil obtained from their blubber. By the 16th Century, both in Europe and Japan, whaling had become a specialised profession with boats, trained crews, and harpoons of various kinds. Whaling became an important industry when the demand increased for whale bone used in women's apparel like corsets, spermaceti used in candles and ointments, ambergris used in perfumery, whale oil for lighting.

The ease with which whales can at present be slaughtered is leading to their extinction and since this would also bring the whaling industry an end, for hard-headed practical reasons if no other, the conservation of whales has gained importance.

The International Whaling Commission set up by the International Whaling Conference held in Washington D. C. in 1946, meets every year to review regulations in the light of latest catch statistics and results of scientific research. It is advised by a Scientific Committee of Biologists. Unfortunately, their advice is not being scrupulously followed and this neglect has led to Blue and Fin whales being depleted to danger levels. The serious drawback is that member nations have not been able to agree on separate quotas for each species, still following the old practice of referring to the catch in terms of Blue Whale Units or B.W.U. which is based on the relative oil production of different species.

1 Blue Whale=2·5 Hump back=6 Sei.

The Scientific study made of cetaceans in recent years has added immensely to man's knowledge of these fascinating and highly intelligent animals and it is the dissemination of this information and the interest that the world public can be made to take in it that is the surest guarantee to the conservation of the whales.

The study of cetaceans in marine aquaria indicates that these animals are remarkably intelligent. They are docile and when taken from water do not struggle, provided they are handled gently, realising that the captors intend no harm.

They enjoy co-operating with trainers to learn tricks and love acrobatics in which they indulge even in the natural state. The Pacific dolphins, *Stenella roseiventris*, swim in large schools. They are called ' Spinners ' because at times they all leap out together and rotate about their longitudinal axis in the air before falling back. Even killer whales, which have the reputation of being fierce, have proved tractable and docile. A 24′ Killer caught off British Columbia was towed in a floating pen to Seattle. Called ' Namu ', he permitted his trainer to ride him, although he could have bitten him in half if he wanted to.

Cetaceans are naturally social and used to co-operating with members of their own species. They make a variety of sounds in communicating with each other. Some of these communications are at a frequency of 100 kilo-cycles per second, far above the upper limit of human hearing which is 20 kc.

This excellent book is a compilation of contributions from whaling countries all over the world, checked by specialists on the subject and edited by Dr. Leonard Harrison Mathews, former director of the Zoological Society of London. It is very well written and with beautiful photographs and illustrations ; a book that every naturalist should read.

G. S. RANGANATHAN

9. ECOLOGY OF REFUSE TIPS. By Arnold Darlington. pp. xii+138 (20 × 13 cm) with eight plates. London, 1969. Heinemann Educational Books Ltd. Price 25 *sh.*

With the population explosion all over the world and consequent larger and larger development of industries in the under-developed and developing countries which mimic the more highly technologically developed countries and the so-called highly civilised countries, the problem of pollution has become one of top priority because of its detrimental effects on the health and welfare of a nation. These detrimental effects are two-fold : one that the accumulation of refuse contaminates the air and the whole environment and leads to epidemics and increase in diseases and secondly to combat this one has to have chemicals which combat their spread. The latter in turn create their own problems particularly from their dangerous effects and from their indiscriminate use. For example the greatest problem of the development of nuclear energy is the disposal of its refuse. D.D.T. which is used most indiscriminately not only against crops pests but also as a house-hold pesticide has become so dangerous that it contaminates our food and affects even the milk of woman.

The question of combating pollution created by garbage particularly in big cities has drawn the attention of Governments and people to its inherent dangers. The present book is a very timely one and can be usefully read not only by the specialists but by the common man also for it is more the latter who is more concerned and affected by the accumulation of refuse particularly in large cities. Not only does the author touch upon the methods of disposal of refuse but goes scientifically into the building up of different kinds of soils under refuse accumulation which would help later in using relevant methods. In short the author very wisely deals with the study of ecological conditions of the refuse heaps for on their knowledge will depend their disposal. Naturally in ecological conditions he mentions the development of flora and fauna on them, for terrestrial invertebrates play a large part in spreading the contaminants.

The author ends the book with a very useful chapter devoted to ' Conditions at the domestic refuse heaps ' which would be very helpful to municipalities concerned with the methods to be adopted for disposal or treatment of different kinds of garbage whether it is domestic garbage or industrial.

An excellent contribution of both theoretical, practical use for individuals, public health scientists and municipal or government agencies.

F. R. BHARUCHA

Miscellaneous Notes

1. THE SPEED OF THE JACKAL (*CANIS AUREUS* LINN.)

On 5th October 1971 at about 11.00 p.m. on our way back to the Ghana Sanctuary from our roost netting operations, we saw a jackal, *Canis aureus* Linnaeus near the breeding colony of the aquatic birds. As the sides of the road were inundated, the jackal could not escape, and began running at full speed along the road in front of our jeep. We followed it, keeping more or less a constant space between the jackal and our jeep for about a kilometre and noted that the speedometer stayed at 40 km/hour.

Again on the night of 13th October 1971 at the same place, we had a similar opportunity to record a jackal's speed over a distance of about one kilometre and here again we recorded 40 km/hour.

B.N.H.S. Bird Migration Study
Camp,
Keoladeo Ghana Sanctuary,
Bharatpur,
Rajasthan,
October 20, 1971.

I. JOSE MATHIAS
K. S. R. KRISHNA RAJU
J. D. PANDAY

2. ON THE FEEDING HABITS OF CRABEATING MONGOOSE (*HERPESTES URVA*) IN CAPTIVITY

A female Crabeating Mongoose (*Herpestes urva*) received at Nandankanan Biological Park (Orissa) on 1-ii-1971 whenever offered hard-shelled snails, usually selects the biggest snail first and carries it in her mouth to a suitable place such as a wall, water or feeding trough. Then with her back to the wall she holds the snail in her forepaws, rises on her hind legs and crashes the shell with force between her hind limbs and on to the hard surface behind her. While smashing the snails, the hind limbs are kept slightly apart and the tail to one side to avoid hitting them. She picks up the partly broken snail, eats the exposed fleshy portions of the snail and the process is repeated till all the fleshy portions are consumed. Thereafter the other snails are taken one after another usually from the biggest to the smallest and processed in the same manner. She deals with the hard-shelled snails in this manner daily but when the fleshy portions of snails removed from the shells or fish are given along with hard-shelled snails, the latter are ignored.

Another male maintained on a diet of fish and snail flesh since 24-i-1965 when given hard-shelled snails along with the female from February, 1971, showed no interest in breaking the snails for the first ten days but used to observe the actions of the female kept in the same enclosure. From the 11th day it started breaking and eating the hard-shelled snails in the same manner as the female.

A second female received on 15-ix-1971 breaks and eats hard-shelled snails. All the mongooses are in excellent health on a diet of fish and snails. They refuse to take fruits, roots and nuts.

Prater (1971) in the BOOK OF INDIAN ANIMALS states that 'it is recorded of an animal kept in captivity that it would take hold of any hard object, such as stone or golf ball, and holding it in its forepaws stand up and crash it to the ground, hurling it with great violence between its hind legs,....... The habit is probably an indication of the way in which this mongoose kills and breaks up hard-shelled crabs and molluscs on which it feeds'. Our observations confirm the presumption of Prater (loc. cit.) that this habit of breaking the snails may be the usual feeding habit of this mongoose.

VETY. ASST. SURGEON, L. N. ACHARJYO
NANDANKANAN ZOO,
P.O. BARANG,
CUTTACK.

WILD LIFE CONSERVATION OFFICER, R. MISRA
ORISSA,
CUTTACK-1,
January 19, 1971.

3. EXTENSION OF RANGE OF THE MONGOOSE, *HERPESTES PALUSTRIS* GHOSE (MAMMALIA: CARNIVORA: VIVERRIDAE), WITH A NOTE ON ITS ENDOPARASITIC NEMATODE

The recently described mongoose, *Herpestes palustris* Ghose from the Salt Lakes, near Calcutta (1965, *Proc. Zool. Soc., Calcutta,* **18** : 173–178) has also now been found at Bhasna, *c.* 47 km. south-east of Diamond Harbour, 24-Parganas district, West Bengal, on 28 September, 1967. This extends the range of the species by some 110 km further to the south.

This mongoose is very common in this locality and is found to feed mainly on fishes and aquatic snails, as it does in the Salt Lakes.

The specimen, an adult ♀, measures: Head and body 300 mm, tail 248 mm, hindfoot 52 mm, ear 23 mm. The number of mammae are 3 pairs (1 abdominal + 2 inguinal).

The specimen was examined for endoparasites. Nothing was found except 2 ♂♂ and 1 ♀ examples of a strongylid nematode worm from the rectum. These worms are of special interest because they constitute the first record of nematode worm from the rectum of an Indian mongoose and exhibit quite different morphological characters than the nemotodes *Pulmostrongylus fengi* Hsü, 1935, known from the lung of the Crabeating Mongoose, *Herpestes urva* (Hodgson), *P. herpestis* (Khera 1956) Yeh 1958, from the pleural cavity of the Small Indian Mongoose, *Herpestes auropunctatus* (Hodgson), *Herpestostrongylus herpestis* Khera, 1956, from the body cavity, lung and gall-bladder of the Common Mongoose, *Herpestes edwardsi* (Geoffroy), and *Arthrocephalus herpestis* Khera, 1956, from the small intestine of the Ruddy Mongoose, *Herpestes smithi* Gray. The specimens also show a great deal of difference from the nematodes, *Rictularia* sp. (= *Diserratosomus mungoosii* Mirza, 1938) and *Spirura marayani* Mirza and Basir, 1938, from the intestine and stomach respectively of *Herpestes mungo* [= *Herpestes edwardsi* (Geoffroy)]. However, of the abovementioned nematode genera known from the mongoose, the present three specimens show strong affinity to the genus *Herpestostrongylus* Khera, 1956. The specimens are currently under study by one of the authors (Y.C.).

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA,
April, 24, 1972.

R. K. GHOSE
Y. CHATURVEDI

4. NOTES ON THE BARASINGHA, *CERVUS DUVAUCELI BRANDERI*, IN THE KANHA NATIONAL PARK

In former times the southern subspecies of Barasingha, *Cervus duvauceli branderi*, was common in wide areas of Central India. Due to heavy shooting and destruction of the habitat Barasingha has experienced a drastic decline since the last century. In 1938, 3023 animals were counted during a census by the forest department in the Kanha National Park (Mandla Dist., M.P.)

Today the population in Kanha N.P. is reduced to 70 to 80 animals. It is most probably the last remnant surviving of the southern subspecies of Barasingha. Unless adequate protection is provided, this population will reach the point of no-return soon.

In recent years several conjectures have been made on the possible limiting factors in the Kanha-population of Barasingha. Schaller (1967)[1] suggests the disease brucellosis and heavy predation by man and tiger as possible reasons for the decline of the population.

Barasinghas disappear yearly from the central open areas of the Kanha N.P. shortly after the monsoon rains have ceased and remain almost undiscoverably scattered in different areas until the beginning of the rutting season in mid-December. This was considered to be the most critical period in their annual cycle, but only a few reliable data were available on their habits during this season.

In April 1971 the World Wildlife Fund raised, funds for a Barasingha-project in Kanha, with the intention of obtaining reliable data on the decline of the Barasingha-population, the causes and possible remedies.

Cervus duvauceli branderi is a species which is mainly confined to open high-grass areas growing along water courses, but has expanded its range to a variety of forest types too. The present project intends to gather information on all ecological and environmental aspects of the surviving population.

In connection with this, the composition and distribution of the endemic grass-flora was studied. The Kanha-meadows have been burned yearly since the beginning of this century to prevent later uncontrolled fires. However, whereas some species of grass-flora adapt themselves to annual burning others are killed off and therefore it is likely that the flora is in a continual state of change. Annual burning is certainly one of the main influences on the endemic grass-flora.

This year an obvious difference in density as well as in the composition of the grass-flora between the Kanha-meadows and other open areas was found. Species such as *Themeda triandra* or *Apluda mutica*, which are of importance for most of the ungulates in the park, have disappeared from wide areas of the Kanha-meadows whereas they occur still in maximum height and density in smaller open areas somewhat distant from the Kanha-meadows. Other, mostly smaller or annual grasses occur more frequently in the Kanha-meadows, but they cannot make up for the lost species. The result is a general poor growth of grasses as far as density, height and composition is concerned.

This does not remain without reaction on the ecology of the animals in the park. It may have detrimental effects on the migration pattern of an endangered species, especially if the species shows such a distinct preference for dense high-grass areas as Barasingha does after the monsoon. This fact seems to be of great importance.

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[1] Schaller, G. (1967) : The Deer and the Tiger. Chicago & London.

On the other hand it stands to reason that the present remnants of the Barasingha in the Kanha N.P. should not be taken as representative for the conditions in former times. The last population of *Cervus duvauceli branderi* lives isolated, with no contact with either other populations or other possible habitats in the surroundings.

Thus as far as they can be reconstructed the requirements of past populations have to be compared with the present ecological conditions. After these considerations only can we decide whether the present habitat in Kanha N.P. corresponds with the needs of the Barasingha and in what form corrections should be undertaken.

In June 1970 a 69-acre enclosure with tiger-safe wire-mesh had been completed in Kanha, enclosing an area of 2/3 grassland and 1/3 Sal-forest (*Shorea robusta*) and offering adequate opportunity to the Barasingha to breed under natural conditions. Moreover it facilitates the recording of the feeding habits and other ecological facts. Two hinds and two stags were introduced into the enclosure in August 1970. A male fawn was born in the enclosure the following month.

In August 1971 one pregnant hind was added to the enclosed group. Its fawn was born in mid-September.

Thus the enclosed group now consists of 2 adult stags, 1 yearling stag, 3 hinds and the recently born fawn. This represents a small breeding herd of a good composition, which promises to increase by further births within the next year.

UNIVERSITY OF ZURICH, CLAUDE MARTIN
SWITZERLAND,
November 19, 1971.

5. AN EXAMPLE OF 'PAGET'S POCHARD' FROM INDIA

(*With a plate*)

'Paget's Pochard' was the name originally given to the hybrid between the Pochard *Aythya ferina* (Linnaeus) and the Ferruginous Duck *Aythya nyroca* (Linnaeus).

Through the kindness of Mr. J. C. Daniel, of the Bombay Natural History Society, we have been asked to examine and report on an example already correctly identified as this hybrid. It is a drake and was netted on February 15th 1968 at Ghana Sanctuary, Bharatpur, India and is registered as No. 126-68 in the collection of the Bombay Natural History Society.

This bird conforms closely to examples of this hybrid described by Gillham, Harrison and Harrison (1966)[1] from England, but this appears to be the first one identified from the Indian subcontinent. Its description is as follows:—

Crown, head and neck: rich chestnut-red, slightly darker on crown, with a well-developed white chin spot. Upper breast a deep coppery-red; lower breast darker, with pale ash-coloured edges to feathers. The lower margin of the breast shield is well-defined, contrasting sharply with the rest of the underparts.

Flanks, central and lower belly finely vermiculated with grey and white, rest of upper belly white, but with traces of vermiculations. The under tail coverts are sooty-grey centrally, with whitish tips.

The upper mantle is sharply defined dark chestnut-red, while the lower mantle is dark grey, obscurely and closely vermiculated with pale ash. Rump, upper tail-coverts and tail, dark grey.

The wing: the coverts are uniformly grey, the tips of the greater wing coverts at the anterior edges of speculum being darker sepia. The speculum is off-white, merging to grey posteriorly and with a narrow white posterior margin. The innermost secondaries are uniform grey. The primaries are grey with pale inner vanes where the speculum extends onto these feathers. The under wing coverts are white with greyish tips. The long scapulars (tertials) are greyish-brown, lightly peppered with pale ash.

The bill, legs and feet are recorded as being as Pochard. The iris was orange, with a whitish inner ring.

Measurements (in mm)

Wing:	.. 207
Bill:	
length from feather margin	.. 43
width at nostrils	.. 18
width at widest point	.. 19
nail	.. 9
Tarsus:	.. 32
Middle toe without nail:	.. 61

Discussion

This hybrid is a typical intermediate type between the two parent species. It closely resembles examples of this hybrid described by Gillham, Harrison and Harrison from England. In the field, it could well have been mistaken for a Ferruginous Duck, except for the black

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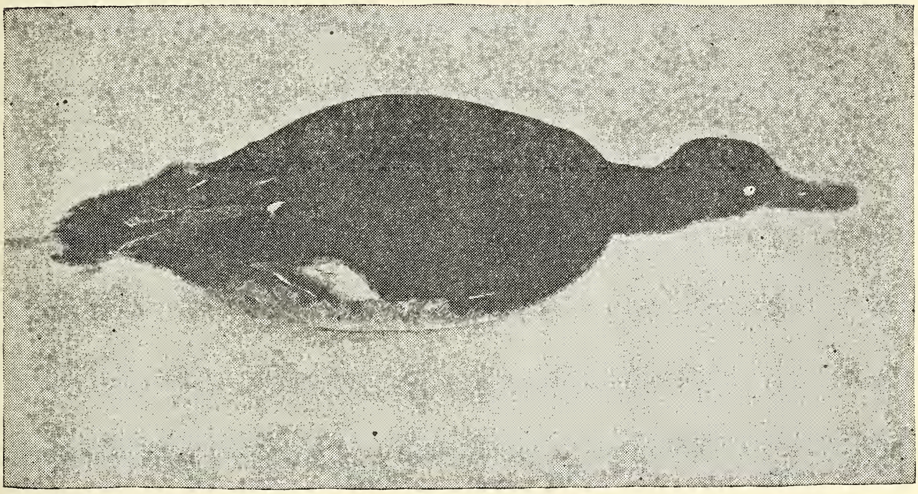
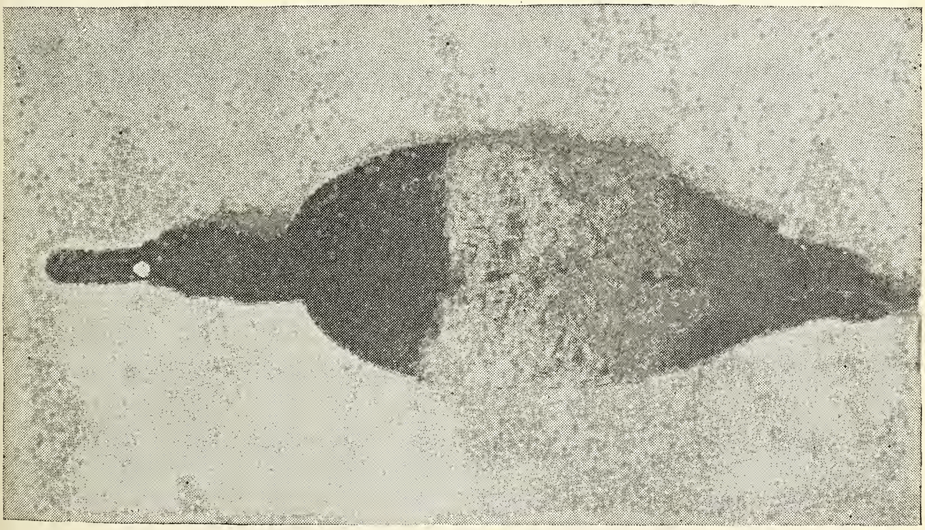
[1] Gillham, Eric, Harrison James M., and Harrison Jeffery G. (1966): A study of certain *Aythya* hybrids. *Wildfowl Trust* 17*th Ann. Rep.* pp. 49-65.





Paget's Pochard

Above: Dorsal view; *Below*: Ventral view.

(*Photos: Pamela Harrison*)

tip to the bill, which even in the skin can still be seen to extend across the full width of the tip and slightly up the sides, whereas in the Ferruginous Duck, only the nail is black. The iris is also intermediate between the parent species, that of the Pochard being red and the Ferruginous Duck white.

It is interesting that this appears to be the first example of this hybrid to have been found in India. Both species have overlapping breeding ranges to the north of the subcontinent in the U.S.S.R. In areas where the Ferruginous Duck is common, this hybrid is likely to be overlooked, in view of the similarities in the field, whereas in the British Isles, where the Ferruginous Duck is rare and the intensity of bird watching much greater, this hybrid has been observed much more frequently. Four specimens and four field identifications were listed up to 1965 by Gillham, Harrison and Harrison, all from southern England.

ACKNOWLEDGEMENTS

Once more, we are most grateful to Mr. J. C. Daniel for the loan of the Indian hybrid skin. We are also much indebted to Dr. Pamela Harrison for the photographs of the specimen.

HARRISON ZOOLOGICAL MUSEUM,
SEVENOAKS, KENT,
ENGLAND,
November 24, 1971.

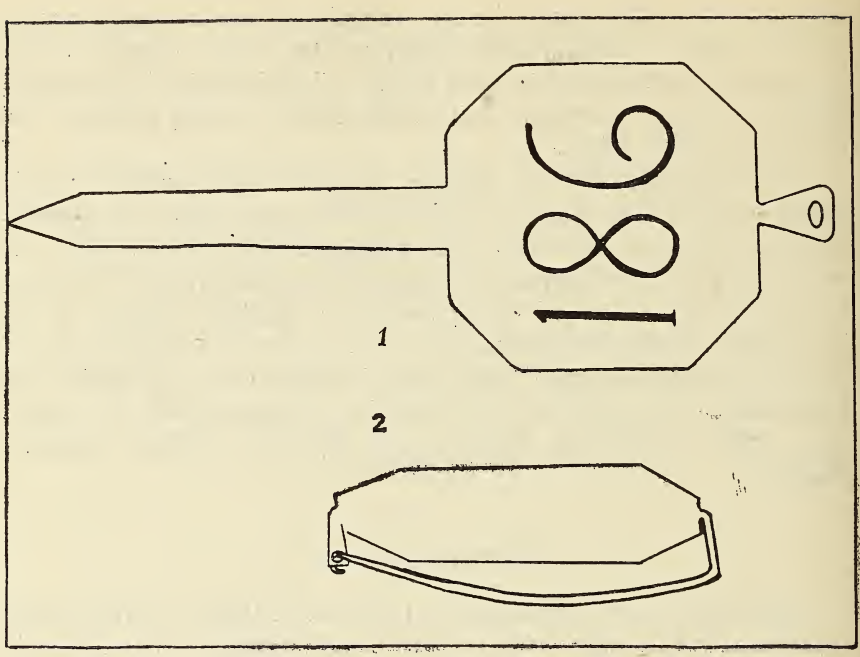
JAMES HARRISON
JEFFERY HARRISON

6. A NEW WING TAG FOR MARKING VULTURES

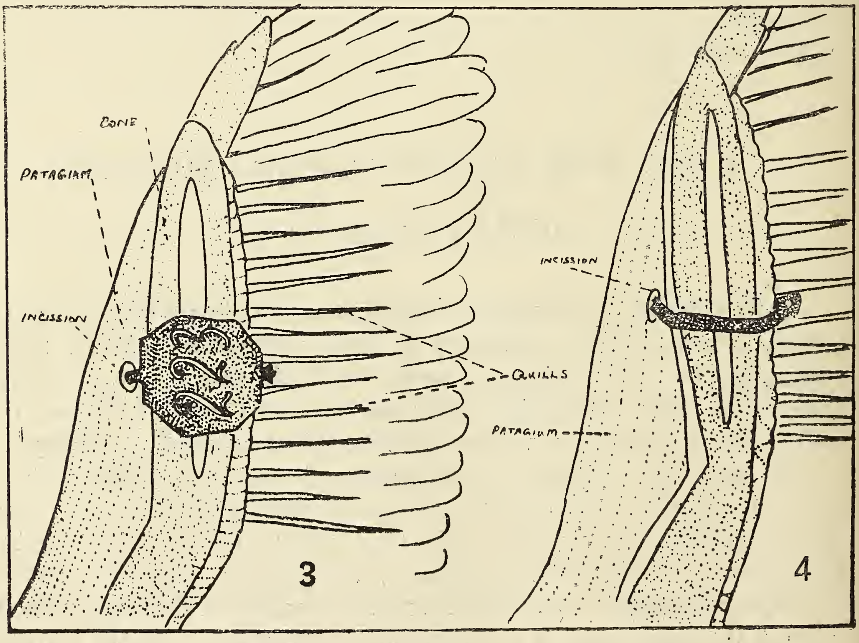
(*With four text-figures*)

While studying the ecology and behaviour of vultures in Gir Forest, Gujarat, I have found it necessary to band vultures to estimate their population by the marking-recapture method, and to study their movement. Since conventional tags and bands are either too small to read easily in the field or are less durable, this wing tag was developed.

The wing tag is a 90 mm broad hexagonal aluminium plate with a loop on one side which tapers at the tip and fits into a slot in an extension of the opposite side. The tag is placed on the bird's wing by passing the loop through a slit made in the patagium skin folds above the carpometacarpus. To avoid the metal extension at the bottom from pressing the quills apart it is narrowed at the base. The tag is kept



Text-figures 1 & 2. *Above* : Tag before banding. *Below* : Shape of the tag after banding : side view.


CONE
PATAGIAM
INCISSION
QUILLS
INCISSION
PATAGIUM
3
4

Text-figures 3 & 4. The tag *in situ*.
Left : dorsal view ; right : ventral view.

loose and it does not press against the muscles. The tag is painted bright yellow on the outer surface. The thickness of the aluminium plate is 18 gauge.

Before trying out the tag on wild vultures it was fitted on two captive adult whitebacked vultures *Gyps bengalensis* on 20 December 1970. Within two days the wound healed and the birds did not appear to be affected by the tag. The birds did not attempt to pull the tags off. After a month one of these birds died for reasons other than the tag, while the second bird was released four months later with the tag.

Twelve more whitebacked vultures were tagged from 10th June to 7th November 1971. One of the birds tagged in June with tag No. 105 was resighted about eight kilometres away from the marking site on 11 December 1971 with no visible ill effect, at a carcass with many unbanded vultures. This same bird was again sighted around the same area at a lion kill with other vultures including another tagged bird whose number could not be read due to distance. One of the birds tagged in June was also reported to be feeding off a carcass with other vultures about 30 km from the marking site in mid-August, 1971. The peasant who saw this bird could not read Arabic numerals.

The advantages of the tag are:

1. The tag is big enough to hold big numbers or codes to be read in the field with the least difficulty.
2. It is very light for these huge birds, and does not affect the flight.
3. The metal does not affect the body tissue of the bird.
4. The tag is durable, and the numbers are expected to last for several years.
5. This tag might effectively replace the conventional leg bands for vultures and other large birds with similar flight patterns.

ACKNOWLEDGEMENTS

Mrs. Almitra Patel, Gir Project Officer, took trouble to get the tags made according to the design I provided. The Bombay Natural History Society has given me opportunity to do the present study through the Gir Project.

B.N.H.S. GIR PROJECT,
SASAN GIR,
GUJRAT,
INDIA,
February 15, 1972.

ROBERT B. GRUBH

7. THE HOUBARA BUSTARD *CHLAMYDOTIS UNDULATA* (JACQUIN) IN KASHMIR

Three weeks ago a local Shikari came to me with a male Houbara Bustard. This is the first time that I have ever heard of one having come into Kashmir.

The Bustard was shot in an area called Hajjan which is 20 miles north-west of Srinagar. This area is mainly paddy growing land and also maize depending on the water conditions for growing paddy in a particular year. In between this area there are bits of land which are kept for grazing village cattle and have numerous small mounds. In these areas there is a particular grass known in Kashmir by the name 'Krishim' which the cattle or sheep do not eat in the summer when it is green. The villagers harvest it in early November when it is dry and use it for feeding sheep. Normally in areas like this there is an abundance of grasshoppers.

We had a few days of very cloudy weather and a light snowfall in the higher mountains which, I think, was the reason for this Bustard straying off its normal migration route.

NEDOU'S HOTEL, COL. HARRY NEDOU
KASHMIR,
November 19, 1971.

8. EXTENSION OF BREEDING RANGE AND OTHER NOTES ON BLACKSHAFTED LITTLE TERN (*STERNA ALBIFRONS SAUNDERSI* HUME)

While on a study tour under Project 453, W.W.F. of the Great Indian Bustard [*Choriotis nigriceps* (Vigors)] at Mithapur, Okhamandal, Jamnagar District, Gujarat (14-16 June, 1971), I visited the salt marshes near Okhamandi at the neck of the Okhamandal peninsula. Here, on the semi-dry mud flats, I found two nests of the Blackshafted Little Tern (*Sterna albifrons saundersi* Hume) about 40 metres apart from each other, with one egg in each. Both were in shallow cattle hoof-prints, one lined with tiny shells and the other not. The eggs differed from those which I have seen of nominate *albifrons* in Saurashtra, being less marked, lighter buff or biscuit-brown, with small black spots, and one egg had two small spots of Indian red colour; I agree with Stuart Baker (NIDIFICATION **4**: 382) that the eggs of *saundersi* are distinct from those of *albifrons*—incidentally, Stuart Baker recognised *saundersi* as a full species.

Two breeding birds were obtained and their subspecific identification has been confirmed by Mr. Humayun Abdulali extending the breeding range of this subspecies which has so far only been known to nest around Karachi.

It appeared to me that there was no regular colony as in nominate *albifrons*. The nests were relatively far from each other, and not near water; some saltwater pools were about half a mile away and the open sea about one-and-a-half miles or more. The birds were comparatively silent and did not call out vociferously and become agitated as do *albifrons* when disturbed at the nest (could this have been due to incomplete clutches ?). The tail appeared more forked and when settled on ground the white patch on the forehead is more prominent, the line between the black and the white being straight while in *albifrons* the black tapers to a point in front. Moreover, the legs of *saundersi* are olive yellow with black, while those of *albifrons* are fleshy pink to orange-red or yellow. The lighter coloration in plumage of *saundersi* is difficult to recognise in the field. However, the blackish tip to the bill seemed more extensive but this has to be confirmed from skins.

Saundersi has been obtained in the Gulf of Kutch (Abdulali, *JBNHS* **59**: 657) and I have found nominate *albifrons* nesting in Bhavnagar. It would appear from the records available that *saundersi* is ordinarily found on saltwater and also nests in saline areas. I am fairly confident however that I have found what I believe was *albifrons* nesting close to both fresh and salt water. Nominate *albifrons* has a yellow bill with a small black tip. The lower mandible of *saundersi* also has a more prominent kink on the under-surface which is sometimes fairly visible.

In a recent letter addressed to me Mr. Abdulali writes :

' In view of your remarks, I have had another look at all the specimens available in the Bombay collection and can confirm the difference in the size of the black tip and shape of the bill mentioned by you. However, we have a specimen, collected by Ticehurst in Karachi and marked *saundersi* by him, in which the shaft of the first primary is not quite black. Similarly, there are other specimens in which the black and white on the forehead agrees with that of *saundersi* but the primary shafts are not all-black. Actually in the Catalogue of the Birds in the Collection of the Bombay Natural History Society, I have listed 4 birds from Rewas, Dharamtar Creek, Kolaba District (near Bombay), under *albifrons* which are presumably the specimens referred to as *saundersi* in INDIAN HANDBOOK (**3** : 65). There would appear to be evidence that there is some inter-grading between *albifrons* and *saundersi* as would be expected, unless they are distinct species.

Or the differences may be due to age or season. The breeding colonies in Sind and Gujarat still provide interesting fields of study'.

DIL BAHAR,
BHAVNAGAR-2,
September 6, 1971.

R. S. DHARMAKUMARSINHJI

9. SOME BIRD NOTES BY W. F. SINCLAIR

W. F. Sinclair, C.S., one of the earliest members of the Society, was a prolific contributor to the first 13 volumes of the Journal on subjects ranging from *Nux Vomica* and Fertilisation of Vanilla Flowers by Bees, to A Stranded Dolphin, Snipe sitting in the open, and on the Indian Breeds of Dogs. A vote of condolence on Mr. Sinclair's death at a meeting of the Society held on 10 July 1900, proposed by E. H. Aitken (Eha), reads in part: ' And while his fertile pen enriched our Journal, his liberality enriched our library, and his industry our collections. When he was at Alibag (Kolaba, Maharashtra), the constant stream of specimens which flowed in from Mr. Sinclair was almost an embarrassment to even our indefatigable Secretary (H. M. Phipson). Skins, eggs, bones, shells and great jars of ' mixed pickles ' kept coming in faster than they could be examined and put in their places. And the list would be long of the books and journals which he gave to our library.

An interleaved copy of Jerdon's BIRDS OF INDIA in the Society's library originally belonged to Mr. Sinclair. Some of the hand-written notes in it, which appear to be worth drawing attention to, are reproduced below. The scientific names are converted to those in current use :—

p. 8. **King Vulture** *Torgos calvus.* In Marathi, *Rajgid* or King of Vultures, is the Adjutant Stork to whom alone the present bird gives way. [The King Vulture has long been said to have precedence over the other vultures at a carcass, but several observers have recorded the incorrectness of this belief. The Adjutant Stork is now rare all over the country, but this appears to be a plausible explanation and another instance of a misapplication of a vernacular name—H.A.]

p. 72. **Crested Hawk Eagle** *Spizaetus cirrhatus.* The cry is a sharp note twice or thrice repeated ' kwee-kwee ' (crescendo). It is not uttered on the wing, but it will sit on trees and scream at intervals for half-an-hour. It is essentially a forest bird and goes through trees and bush like a Sparrow Hawk, very bold and fierce, and raids on its whole neighbourhood including villages. It also often sits inside a tree, and if approached will hop from branch to branch through the tree, and go off on the other side like a Sparrow Hawk.

The common wood eagle from the Sabarmati Valley (at least) down to the hills south of the Savitri between Kolaba and Ratnagiri.

p. 78. **Crested Serpent Eagle** *Spilornis cheela.* Kokad of the Kolaba Katharis. I got a ferruginous specimen in the Koina Valley under Mahableshwar. The cheeks were slaty black.

p. 80. **Osprey.** *Pandion.* Near Abu Road. ' Strange to say, attacked a heron and hawked it fiercely for some time, till the chase passed near me and I turned off the osprey with a shot which missed him '.

p. 82. **Ringtailed Fishing Eagle.** *Haliaeetus leucoryphus.* Nesting at Viramgam, Gujarat. One sharp snort, then two croaks winding up with a scream. Audible a mile off under favourable circumstances.

p. 102. **Brahminy Kite** *Haliastur indus.* I have seen one repeatedly strike a hare which I eventually shot and found all scored over with the hawk's claws. Saw one strike a garfish (*Belone cancila*). The bird was shot and the fish picked up alive.

p. 106. **Pariah Kite** *Milvus govinda.* I knew a very curious case of a man being killed by one of these kites. He was a patient of the Sassoon Hospital in Poona. The Assistant Civil Surgeon whereof was then my chum. The patient had an injury to his foot and was recovering and allowed to sit in the verandah. He fell asleep there and the dressing dropped off. The kite seeing the large red surface exposed, and taking it, I suppose, for raw meat which it might carry off, stooped and struck his claws into it. The wound mortified and the man died.

p. 142. **Spotted Owlet** *Athena brama.* I once saw these birds hovering and stooping like Kestrels. This was in the wide sandy bed of the Sabarmati, 10 miles above Ahmedabad, just after sunset. When they caught anything, they lit on the ground and eat (? ate) it.

p. 223. **Storkbilled Kingfisher** *Pelargopsis capensis.* . . . has three calls (1) quiya, quiya, quiya qui, (2) a hoarse rattling laugh as a note of alarm or excitement and (3) a harsh, croaking squawk when wounded.

p. 231. **Little Kingfisher** *Alcedo atthis.* I found a pair of Kingfishers breeding in a pensile nest of grass in the bank of a canal near Shikarpur in the hot weather of 1881. Probably they did not build it themselves.

p. 243. **Great Indian Hornbill** *Buceros bicornis.* X'mas 1885. Not very uncommon in the forests of the Kolaba District, below Mahableshwar.

p. 249. **Grey Hornbill** *Tockus bicornis.* The beak for rheumatism.

p. 269. **Coppersmith.**

Tokerao = Hammer-king.
Sutar = Carpenter.

p. 271. **Crimsonbreasted Pied Woodpecker** *Picus cathpharius* Hodgson.

From *Kath-phor* = Wood-splitter.

p. 341. **Pied Crested Cuckoo.** The ' Chatak ' of Hindu poetry is said to live on drops of rain.

75, Abdul Rehman St.,
Bombay-3,
May 8, 1968.

HUMAYUN ABDULALI

10. NOTES ON LITTLE KNOWN LIZARDS FROM THE RAJASTHAN DESERT

Some pioneering work was done on the reptiles of the Rajasthan desert under the leadership of Professor Daya Krishna, during a Project financed by UNESCO. Unfortunately, however, this detailed work has not been published so far. The collections made from 1953 to 1955 during the tenure of the project did not include the lizards which I am reporting in the present communication with the exception of *Eumeces taeniolatus.* The lizards, under report, were collected from the western Rajasthan during the last few years and some of them are being recorded for the first time from this region.

Hemidactylus triedrus (Daudin)

The Blotched Gecko

Gecko triedrus Daudin, 1802. *Hist. Nat. Report,* IV : 155.
1 ♂ (?)—Bhopalgarh, 50 Km north of Bilara, September 1963.
Snout vent length 72 mm, Tail length 70 mm.

The Blotched Gecko was collected at night near a lit petromax in the Institute nursery situated over a gravel mixed sandy plain, near a hillock. The nocturnal lizard was apparently attracted by the swarming insects around the light. Its stomach revealed three whole beetles, one of which was in a state beyond identification and the two others belonged to *Schizonycha.*

The range of the species extends from Ceylon through much of Peninsular India to the vicinity of Karachi (Minton 1966). From Rajasthan, it has been reported from Ajmer (Smith 1935).

Agama megalonyx Günther

Afghan Ground Agama

Trapelus megalonyx Günther, 1864. The reptiles of British India. London.
1 ♂—Shahgarh, about 100 Km southwest of Ramgarh, September, 1971.
1 ♀—Gadra Road, 60 Km west of Barmer.
Snout vent length ♂ 65 mm, ♀ 70 mm Tail length ♂ 125 mm, ♀ 130 mm.

The specimens were collected on sand dune country having a dominant under-shrub, *Calligonum polygonoides.* The Shahgarh male was found to be active in the morning. Its stomach contained parts of two beetles, and wings and abdomen of a grasshopper. The Gadra Road female was carrying 5 eggs, three on the right and two on the left side. The eggs measured 8 to 10 mm in diameter. Unfortunately the date of collection is not on record.

The species has been reported from Perso-Baluchistan border (Smith 1935), Baluchistan plateau and adjacent Afghanistan (Minton 1966). Murray (1884) reported it from Sind. The present record extends its range further east and the species is being reported for the first time from this desert.

Phrynocephalus euptilopus (?) Alcock & Finn

Vivid-coloured Toad Agama

Phrynocephalus euptilopus Alcock & Finn, 1896. *J. Asiat. Soc., Bengal,* 65 : 556,
1 ♀—Mandla, 100 Km southwest of Ramgarh, September, 1971.
1 ♂ and 10 ♀♀, and 21 subadult, Dhanana, 95 Km southwest of Jaisalmer. September, 1971.
Snout vent length Adult ♂ 66 mm, ♀ 62 mm (range 56-68 mm).
Tail length Adult ♂ 40 mm, ♀ 36·2 mm (range 31-44 mm).

The genus, *Phrynocephalus,* is being reported for the first time from India. I am, however, not very definite about the species of the agamid since the tail length of the Rajasthan material is shorter than the snout vent length. As a matter of fact the tail in all the species included by Smith (1935) under the genus is longer than the snout vent length, except in *P. luteoguttatus* in which both the lengths are equal—an observation confirmed by Minton (1966). The present series also differs from all these species in having comparatively longer body

(Table) and in not having black markings on the tail, and in not having tip of the tail black. I have, however, tentatively placed it under *P. euptilopus* following Minton's (1966) key which mentions that it is the only species which exhibits vivid coloration over the body. In life, the present series showed red, orange, black and white dorsal spots.

TABLE

A COMPARISON OF SNOUT VENT AND TAIL LENGTHS OF VARIOUS SPECIES OF THE GENUS *Phrynocephalus* WITH THOSE OF THE LIZARDS COLLECTED IN RAJASTHAN DESERT

Species	Smith (1935)			Minton (1966)	
	Snout vent length mm	Tail length	% of S v length	Snout vent length mm	% of S v length
P. scutellatus ..	50	70	140	♂ 42-44 ♀ 46	141-148
P. leuteoguttatus ..	40	40	equal	♂ 38-44 ♀ 38-41	? ? (equal)
P. ornatus ..	38	52	136	♂ 35-40 ♀ 40	133-142 119-125
P. maculatus ..	73	120	160	♂ 79-85	138-152
P. theobaldi ..	54	58	108	—	—
P. reticulatus ..	45	60	133	—	—
P. euptilopus ..	60	65	108	—	—
Rajasthan desert *P. euptilopus*	(Present study)				
	♂ 66	40	60·6		
	♀ 62 (56-68)	36·2 (31-44)	58·4		

The lizards were very common, rather abundant, on vegetationless, absolutely bare, concentric, loose, sand dunes at Dhanana but were not so common near Mandla. They were active all through the morning, up to 11.30 a.m. and during the evening. Activity during the morning was more intense as is evidenced by the collection record. In a single day 24 lizards were collected in the morning and only three during the evening. The Toad Agama can run fairly fast. Its speed does not decrease while climbing sand dunes. It has a habit of stopping a while and looking backward towards the chaser. When danger threatens, the agamid buries itself in the loose sand by lateral wrigglings or shivering movements of the body. The limbs do not participate in this activity. The buried lizard leaves a clear mark on the sand and its collection thereafter is not difficult. The lizard was found buried up to a maximum depth of 10 cm. I did not notice the dorsal curling of the tip of the tail as mentioned in *P. luteoguttatus* (Minton 1966). The structural adaptations befitting the genus to the xeric environment, as described by Smith (1935), are also clearly visible in the present series of lizards collected in the Rajasthan desert. All the lizards exhibited vivid coloration on the dorsal side of the body but a few do not possess the darker mid dorsal line running from the neck to the hind limb region.

The stomach contents of 15 Toad Agama showed remains of small ants, beetles, orthopterous and hymenopterous insects. The frequency of occurrence of ants was more than 50 per cent. One of the big females contained in addition remnants of a young lizard.

In the present collection of *P. euptilopus*, females outnumber males. Young specimens of various sizes (Snout vent length 22 mm to 55 mm, Tail length 12 mm to 30 mm) in the series indicate that the hatching occurred during August but surprisingly, a few females still possessed enlarged oocytes.

Eumeces taeniolatus (Blyth)

Yellow-bellied Mole Skink

Eurylepis taeniolatus Blyth, 1854. *J. Asiat. Soc.*, xxiii : 470.
1 ♀—Jodhpur, Research Farm of the Institute situated over a sandy plain with rich flora, captured in Sherman live trap.
Snout vent length 122 mm, Tail length 123 mm.

The stomach of the skink contained chitinous parts of beetles which were not identifiable. The species is distributed from southwestern Arabia to Transcaspia, and east to Kutch and Kashmir. It has also been reported from Rajasthan by Smith (1935) but he did not mention any specific locality. During the UNESCO Project it was collected at Jhunjhunu.

Ophisops jerdoni (Blyth)

Jerdon's Lizard

Ophisops jerdoni Blyth, 1853. *J. Asiat. Soc. Bengal*, xxii : 653.
1 ♀—Jalor, August, 1970.
Snout vent length 76 mm, Tail length 115 mm.

The lizard was collected from the Jalor hills, four kilometres in the southwest direction. A few more were observed but could not be captured. The lizards were not, however, common as reported in the Salt Range area (Hora & Chopra 1923). The lizards were seen on the hillock up to 9 a.m. They were not seen during the evenings. The stomach of the lizard contained mandibles of beetles.

Smith (1935) mentioned that the species is distributed in Northern and Central India, North West Frontier, Baluchistan, Punjab, Cutch and Bellary. From Rajasthan, he reported it from Jaisalmer. The present record extends its range further southeast in the State.

Varanus griseus koniecznyi Mertens

Indian Desert Monitor

Varanus griseus koniecznyi Mertens, 1954. *Aqar. Terrar. Zeitschr.*, 7 : 3-19.
1 ♂—Jodhpur, Research Farm of the Institute.
Snout vent length 285 mm, Tail length 365 mm.

The stomach of the monitor was heavily infested with nematode parasites and contained only a pebble, 15 × 10 mm.

Since Smith (1935) did not classify the species into subspecies, I have followed Minton's (1966) key for determining the subspecies. He mentioned that *koniecznyi* ' occurs in arid habitats from Central India westward through Sind and most of Punjab '. *V. g. caspius* occurs in deserts from Transcaspia to southern Khazakstan and southward through much of Iran and Afghanistan into northern Baluchistan. ' To the west, *caspius* intergrades with the nominate race'.

CENTRAL ARID ZONE RESEARCH INSTITUTE,
JODHPUR,
September 30, 1971.

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Animal Ecologist

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11. TWO UNIQUE METHODS OF FISHING FOR COBITIDS IN TUNGABHADRA RIVER

(*With two plates*)

INTRODUCTION

During the riverine survey work of Tungabhadra drainage it was observed that two conventional but novel type of gears are operated for fishing in the vicinity of Harihar. They are locally known as 'Kallu-sara' and 'Hullu-sara' used for catching coarse (forage) fishes particularly cobitids. These two methods of fishing are restricted to a few fishermen families in Guthur village situated on the right bank of the river near Harihar, and the gear have not been reported so far. Gopinath (1953) and Karamchandani & Pandit (1967) have described similar scare line fishing of entirely different design and structure.

FISHING GEARS

Scare line type—I (Local name 'Kallu-sara'): As the local name itself connotes in Kannada it is a simple bottom scare line made up of paddy straw (*Oryza sativa*) or coir rope, interspersed with small hard limestones in between the two strands of the rope, at 10 to 12 centimetres interval (Plate I). The two ends of the scare line are tied to two thin bamboo poles of 1·5 to 2 metre length for dragging a 50 to 80 metres long rope as well as to scare the fish.

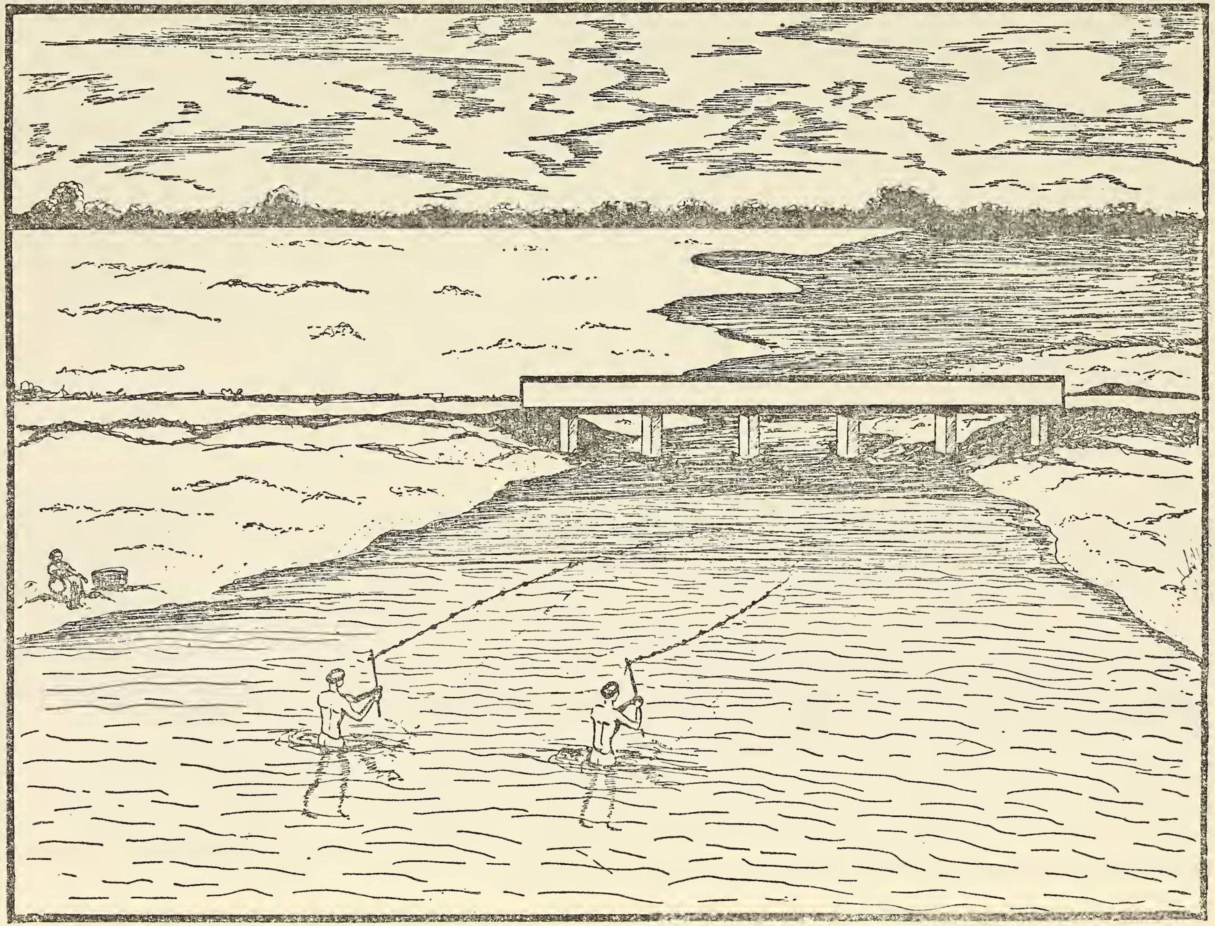
Scare line type—II (Local name 'Hullu-sara'): It is a scare line similar to type I, made out of paddy straw or coir rope. Small bundles of 'bagi hullu' (*Aristida setacea*) tied in the form of brush are inserted in between the strands of the rope at regular intervals of 10 to 12 cm. Old net pieces of one centimetre mesh bar fixed in two to three layers are hung in the centre with a light hollow bamboo pole of 1·0 to 1·5 metre length to serve as improvised float (Plate II). Some time this scare line is operated even without the net in the middle. On either side of this bamboo pole stones weighing about 100 gm are also tied to the scare rope at five metre intervals, which enable to sweep close to the silty or sandy bed of the river. The ends of the scare rope are fastened with thin bamboo poles of 1·5 to 2 metres length which are used to disturb the fish and also to drag the entire 80 to 100 metres long scare line.

DETAILS OF OPERATION

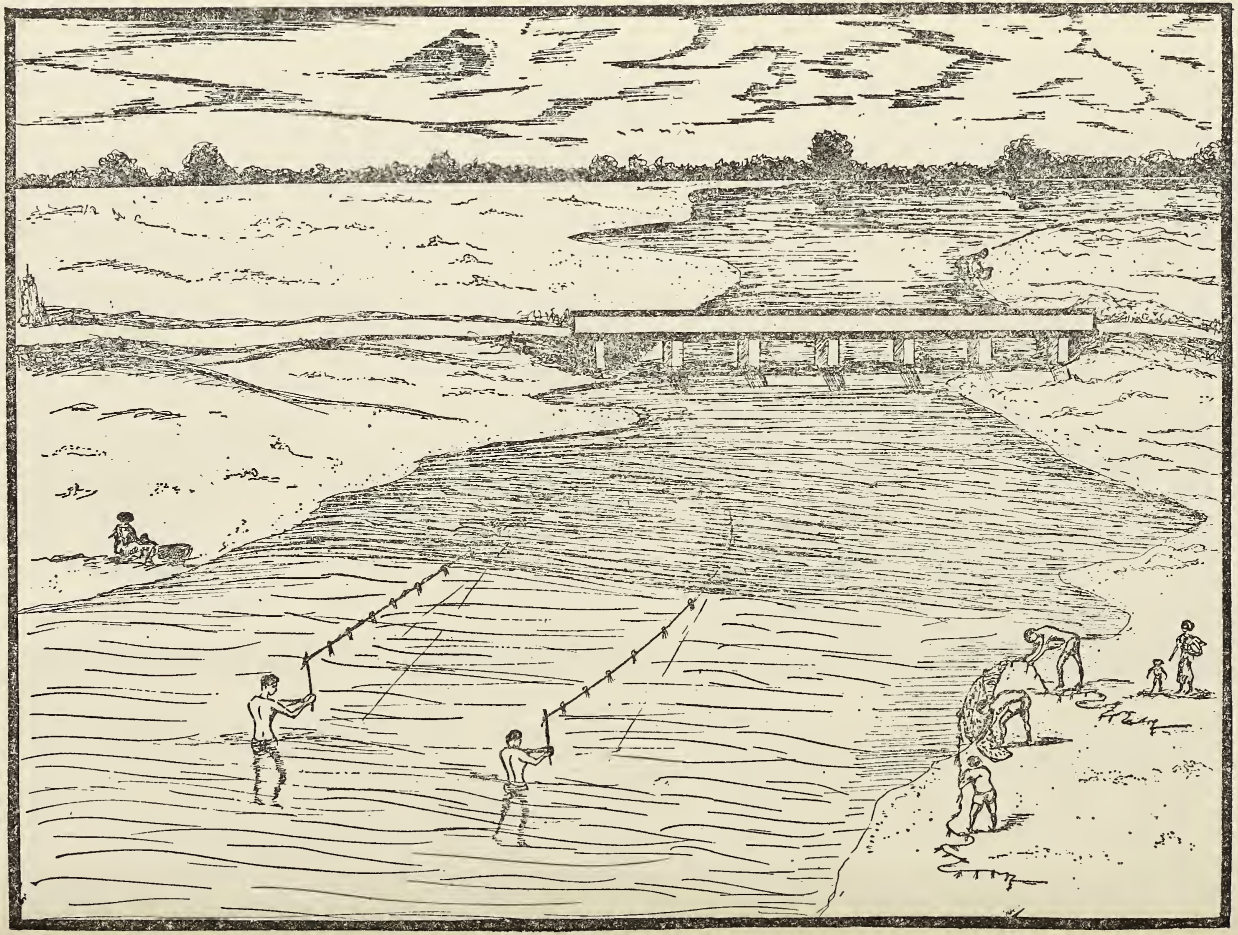
(*a*) *Fishing unit and methods of operation*: A fishing unit consists of three fishermen, two to drag the scare line and the third to disentangle the line from any snags on the river bed and to splash water to turn back fugitives from the line. Usually, the line is operated by a fisherman leading with one end of the line across the river and passing diagonally down stream. As the first fisherman reaches the middle of the river, the second man on the other end rushes downstream to bring up the level with the first. The third fisherman starts splashing at the sides and rushes to the point of entanglement if any. When once the line is in operation, the two on either end of the line move slightly faster than the water current. Careful attention is paid for effective dragging, giving sufficient bend in a semicircular fashion to the line, otherwise the tension by dragging on either side would raise the scare line resulting in the loss of fish trapped. In case a snag is encountered, that portion is lifted carefully by splashing on either side. The two wading fishermen on both sides remain in water and hug the banks to prevent escape and work the banks with poles provided on either end to herd the fish towards the enclosure. As premature closure may bring unprofitable catch, the line is dragged over several shallows before reaching the margin of the river bed. The fishermen select a shingle bank slope which is ideal for hauling. As the two fishermen approach the site selected for hauling they kneel down and gently draw the line, to reduce it into a narrow loop when the fish become increasingly alarmed.

The 'Kallu-sara' is dragged round in a smooth arch and the gap is gradually decreased to drive the fish into a 'hapa' (cloth bag). During the time of dragging 'Kallu-sara' a selective fishing gear for cobitids, the larger fishes escape. As the scare line is operated close to the bottom of the river bed and the cobitids which are usually at the bottom are trapped in the area enclosed by the line. The limestones tied in between the two strands of the scare line disturb the bottom layers while dragging and scare the fish. As a result the fish are diverted towards the river bank and the scare line is then dragged towards the bank where one fisherman is ready with a 'hapa' to trap the fishes. In case of 'Hullu-sara' the two ends are kept some distance apart and the line is dragged slowly so that the fishes move towards the net fixed in the middle. When the net part of the line approaches the fishermen they lift the net quickly to avoid the escape of fish. This net which is non selective, captures smaller size carps, catfishes and other coarse fishes. The complete process requires a very careful operation and smooth execution to get the best catch.

(*b*) *Time and season of fishing*: Usually the fishing is practiced from November to April and sometimes till the end of May, in shallow regions when the water is clear and the current mild. When once the water becomes turbid during monsoon the scare line operation ceases.



Showing fish drive by ' Kallu-sara ' scare line in Tungabhadra River near Harihar.



Showing the operation of ' Hullu-sara ' scare line in Tungabhadra River near Harihar.

Usually the regions with water velocity of 18-25 metres per minute and a depth varying from 0·5 to 1·5 metres are ideal for the operation of these two types of scare lines. In addition to the above factors the width of the river and the nature of its bottom play an important role in successful operations of these nets. This fishing is done generally from 8.00 to 11.00 and 13.00 to 16.30 hrs. to find immediate market for the catch. The catch is usually brought in water in earthern pots to the market at 11.30 and 17.00 hrs. for disposal when they are still fresh.

SPECIES COMPOSITION

The species composition both in ' Kallu-sara ' and ' Hullu-sara ' varies. Generally the coarse fish which do not move far when alarmed and are reluctant to scatter from their surroundings are caught by these nets. The details of the catch in ' Kallu-sara ' in 8 hauls observed by the authors is given below.

Species	Size range in mm	Numbers
Lepidocephalichthys thermalis (Cuv. & Val.)	53-119	about 1,000
Nemacheilus striatus (Day)		
Nemacheilus denisonii (Day)		
Nemacheilus evezardi (Day)		
Nemacheilus (two other species)		
Botia striatus (Rao)		
Puntius kolus (Sykes)	114-167	4
Labeo porcellus (Heckel)	129-136	2
Mastacembelus armatus (Lacép.)	214-253	2

The number of species captured in two hauls of ' Hullu-sara ' their size ranges and numbers is detailed below.

Species	Size range in mm	Numbers
Puntius kolus (Sykes)	63-300	9
Puntius sarana (Hamilton)	142-183	4
Puntius dobsoni (Day)	214-286	3
Labeo porcellus (Heckel)	137-163	5
Bagarius bagarius (Hamilton)	226-230	2
Mystus cavasius (Hamilton)	147-156	2

Among the species captured in ' Kallu-sara ' 99·2 per cent was contributed by cobitids represented by *Lepidocephalichthys thermalis*, *Nemacheilus striatus*, *Nemacheilus denisonii*, *Nemacheilus evezardi* and two other species of *Nemacheilus* with *Botia striatus*. The juveniles of other species was only 0·8 per cent.

In case of ' Hullu-sara ' juveniles of *Puntius kolus*, *Puntius sarana*, *Puntius dobsoni*, *Labeo porcellus*, *Bagarius bagarius* and *Mystus cavasius* were encountered.

Gopinath (1953) has described a fishing method in the backwaters of Travancore, in which a rope fitted with coconut palm leaves is employed as a scareline and the fish *Eutroplus suratensis* and *Garres* sp. are grabbed by hand. Further, Karamchandani & Pandit (1967) have given an account of collecting fingerlings of *Tor tor*, *Tor putitora*, *Labeo fimbriatus* and *Labeo dyocheilus*, *Labeo bata*, *Cirrhina reba*, *Puntius sarana*, *Barilius bendelisis*, *Oxygaster clupeoides* and *Danio* sp., which are trapped in a composite net made of two cast nets, by dragging the scare line in shallow regions of the river Narbada. This method of capturing cobitids is very interesting to observe. Perhaps this is the only area in Mysore State where cobitids are being utilised as food. The coarse fishes are neglected and their fisheries has not developed to the desired extent elsewhere, which may be attributed to lack of efficient gear. The bottom dwelling cobitid fish are quite abundant in shallow areas of the rivers and there is no other fishing gear known to capture cobitids other than ' Kallu-sara ' scare line.

ACKNOWLEDGEMENTS

We are indebted to Dr. N. P. Patil, Director of Research, University of Agricultural Sciences, Hebbal, Bangalore, for his encouragement and facilities. Our thanks are due to Shri M. R. Nettakallappa, Artist of this University, for the drawings.

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October 6, 1969.

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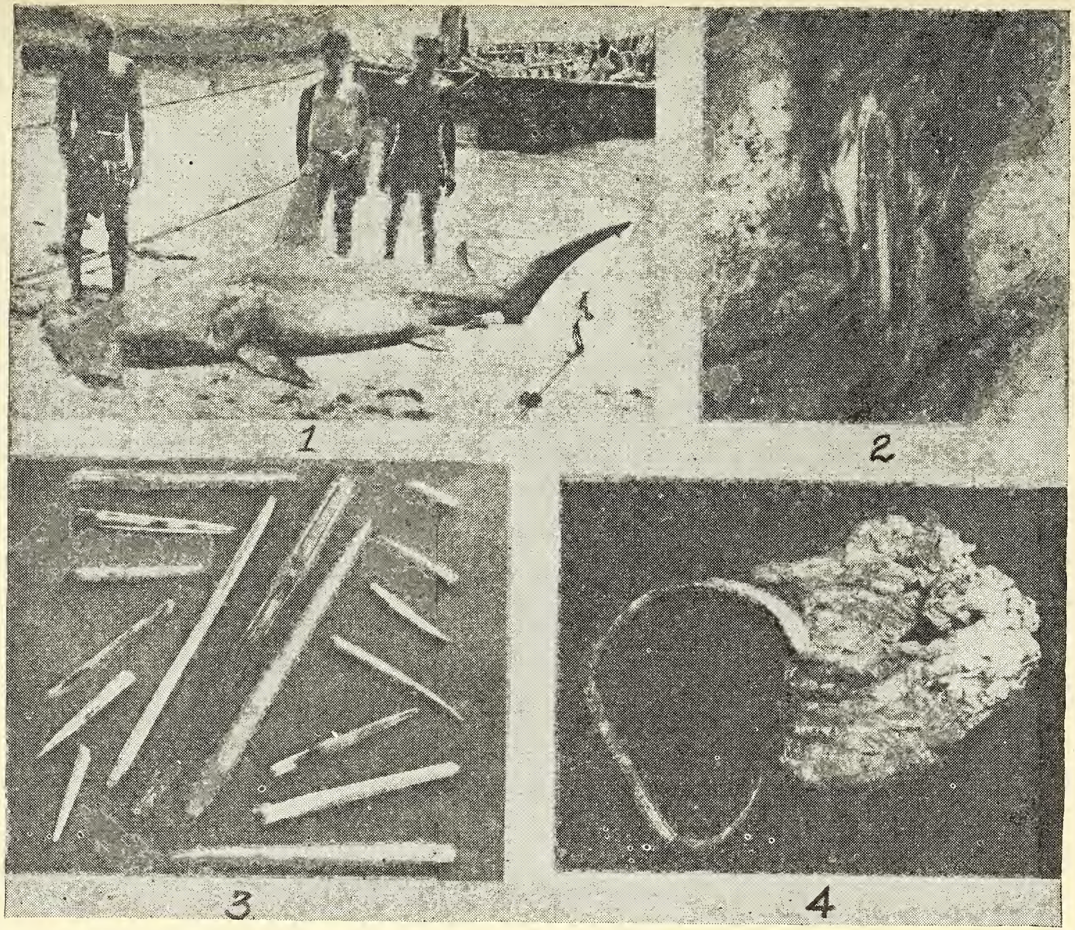
12. ON THE OCCURRENCE OF STING-RAY SPINES IN THE JAWS AND GILLS OF THE HAMMERHEAD SHARK *SPHYRNA ZYGAENA* (LINNAEUS)

(*With a plate*)

It is well-known that sharks are voracious feeders and prey upon a wide variety of marine animals such as planktonic crustaceans, crabs, molluscs, fishes, turtles and seals. While examining a specimen of



PHOTOS: 1. *Sphyrna zygaena* landed at Tuticorin north landing centre ; 2. A spine *in situ* in the upper jaw; 3. A group of spines collected from the jaws and gills of *S. zygaena*. (The brownish-black stain caused by the blood of *S. zygaena* is clearly seen in some of the spines) ; 4. A semi-digested specimen of *Himantura alcockii* recovered from the stomach.

Sphyrna zygaena (Linnaeus) measuring 3·86 metres in total length (Photo 1) which was caught off Tuticorin at 40 fathoms depth by long line on 22nd April, 1971, several spines of sting-rays were found in the jaws and gills (Photo 2). The spines occurred in both jaws of *S. zygaena* but most of them were found in the upper jaw and they were observed to have pierced the jaws and gills deeply. Altogether seventeen spines were present. Of these, thirteen were in the jaws and the rest in the gills. The spines ranged in size from about 60 to 160 mm (Photo 3). *S. zygaena* has the habit of chasing rays on which it feeds (Norman & Fraser 1937; Bigelow & Schroeder 1948). The spines obviously pierced the jaws and gills while the shark chased and attacked the rays from behind as indicated by the position of the pointed ends of the spines which were directed towards the oesophagus. The spines found in the gills probably got stuck there when the shark swallowed the rays. Gudger as quoted by Norman & Fraser (op. cit.) has stated that cyst formation takes place around the spines which are embedded for a long time. However, such cyst formation was not seen in the present case though a worn out spine was collected from the gill region suggesting its presence there for a long time. Most of the spines had brownish-black patches as a result of being stained by blood. The spines most probably belong to the ray *Himantura alcockii* (Annandale) which occurs abundantly at Tuticorin.

Norman & Fraser, and Bigelow & Schroeder (op. cit.), have recorded that sharks like *Galeocerdo*, *Negaprion*, *Carcharhinus* and *Sphyrna* feed on rays and have also reported the occurrence of sting-ray spines in the jaws and other parts of the body of these sharks. Bigelow & Schroeder (op. cit.) have stated that the diet of *zygaena-plana* group mainly consists of fish and in the southern part of their range they chiefly feed on sting-rays. Members of the above group also feed on shrimp, crabs, barnacles, crustaceans and squids. Chidambaram & Menon (1946) in their study of the shark fishery of Madras Presidency have stated that *Sphyrna* spp. feed on cat-fish, big-jawed jumper, oil sardine, cuttle-fish, ribbon-fish, mackerel, white bait, pomfret, *Pellona*, sprat and small sharks. The above authors have not recorded rays among the food items. It is possible that the specimens examined by them were small in size and this probably accounts for the absence of the rays in the stomachs. One partly digested ray which appears to be *Himantura alcockii* was found in the stomach of the present specimen (Photo 4).

Roedel & Ripley (1950) have recorded poison glands in rays and have stated that spines of the rays caused fatalities in human beings and that there is no specific treatment. The specimen of *S. zygaena* reported here did not appear to have suffered from any ill effects due to the poison secreted by the poison glands of the rays eaten by it and looked normal and healthy with no external indication whatsoever of the presence of these spines. Local fishermen state that the occurrence of sting-ray spines in hammerhead sharks (*Sphyrna* spp.) and saw-fish *Pristis* spp.) is common, indicating that these sharks regularly feed on sting-rays.

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13. *ESOMUS DANRICUS JABALPURENSIS* SUBSP. NOV. FROM PARIAT RIVER NEAR JABALPUR

(*With a text-figure*)

Esomus danricus (Ham. Buch.) is one of the common larvicidal fishes in the rivers and ponds around Jabalpur. In the course of collections eleven specimens which are more slender than *E. danricus* have been collected from Pariat River, a tributary of River Narbada. In view of the striking difference in the height of body, the ten specimens are described here under a new subspecies.

Esomus danricus jabalpurensis subsp. nov.

D 8 (2/6); A 8 (3/5); P 15; V 9; C 19; LI 30-32; tr. 7; GR 3. 17; Vert. 30 (16 + 14).

Body narrow, elongate, dorsal and ventral profiles more or less straight. Depth 6·7-8·7 in total and 5·3-6·5 in standard length. Head 4·4-5·4 in total and 3·5-4·1 in standard length, its height 2/3 in length. Eye 2·8-3·2 in head length; snout bluntly pointed, 2/3 in eye. Mouth small, more or less vertical, lips thin, lower jaw prominent. Maxilla does not reach to anterior margin of orbit. Two pairs of barbels, the rostral pair short reaching to posterior margin of orbit, the maxillary pair long extending to middle of ventral fins or beyond. Gill openings wide, isthmus narrow, gill rakers thin and somewhat placed apart.

Origin of dorsal fin above middle of total length, 1st ray short, about half in the 2nd, 2nd and 3rd rays longest, 3/4 in head length, base a little more than eye, 1st and 2nd rays entire, the last divided to base, free margin not concave. Pectoral longer than head, situated in the lower half of body, the uppermost ray longest reaching to beyond base of ventral. Ventral origin a little behind two head lengths from tip of snout, shorter than pectoral, the outer ray longest reaching to base of 5th anal ray. Anal insertion below that of 7th dorsal ray, free margin concave, the first three rays entire, the 1st shortest 1/3 in the 2nd, the 2nd about 1/3 in the 3rd and the longest which is a little less than length of head, last ray cleft to base, anal base as long as that of dorsal. Caudal deeply forked, a little longer than head.

Scales cycloid, 30-32 in lateral and 7 in transverse series, 17 predorsal scales. Lateral line incomplete, extends up to 6th scale below pectoral fin as simple tubes. Vertebrae 30: 16 prehaemal and 14 haemal.

Colour: A black band from tip of snout on to caudal fin along the mid-sides being lighter on snout and caudal. Sides silvery, the part above the black band light grey and pale yellow below it. Dorsal fin lightly spotted.

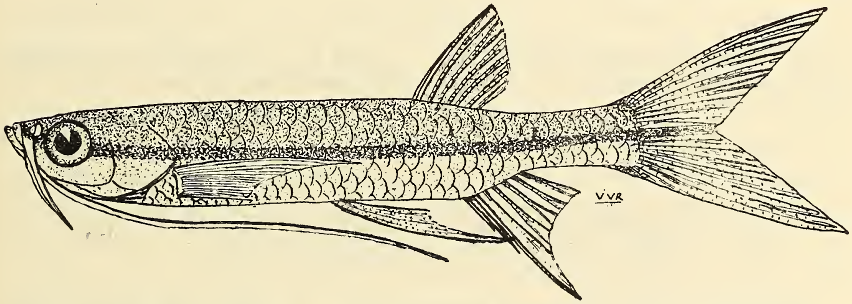

FIG. 1. *Esomus danricus jabalpurensis* subsp. nov. Type, 52 mm total length.

Day (1887, 1889) distinguished two varieties of *E. danricus*, *alta* and *malabaricus* on the basis of difference in the height of body which is $4\frac{1}{2}$ in total length in the former and $5\frac{1}{2}$ in the latter. Hora and Mukerji (1929) stated that this species exhibits a great range of individual variation, especially in the case of barbels, paired fins and lateral band on body. They concluded that various forms described from different localities of India belong to the same species, *E. danricus* in which the lateral line is restricted to 4-6 scales anteriorly; variety *malabaricus* which according to Day is characterised by the absence of lateral line is included in this species. Variety *alta* having a complete lateral line and greater height has been treated as *E. altus* (Blyth). An examination of more than 50 specimens of *E. danricus* and 10 specimens of the subspecies has shown a good amount of similarity between the two, but revealed a marked difference in the height of body which is 3·8-4·3 in standard length in the former and 5·3-6·5 in the latter; according to Hora and Mukerji the same varies from 3·3-4·8 in *E. danricus* from different localities of India. The least depth of caudal peduncle also shows considerable variation being 6-7 in standard length in the former and 10-10·5 in the latter. A statistical analysis of the biometric data of large number of specimens from different localities of India may perhaps result in recognising more than one subspecies of *E. danricus*. The new subspecies can be easily distinguished by its very narrow body, straight dorsal and ventral profile and very narrow caudal peduncle.

The holotype 40 mm (V. 2060) standard length and the paratypes 38 mm (V. 2061), 37·5 mm (V. 2062) and 36 mm (V. 2063) standard lengths are deposited in the collection of the Central Regional Station, Zoological Survey of India, Jabalpur. Register numbers are given in the parenthesis.

CENTRAL REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
JABALPUR,
December 24, 1969.

V. VISWESWARA RAO
H. S. SHARMA

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HORA, S. L. & MUKERJI, D. D. (1929) *Rec. Indian Mus.* **30**: 41-56.

14. A NOTE ON A HIGH INCIDENCE OF FLEA, INFESTATION IN *RATTUS RATTUS*

Ever since the association between rats, rat fleas and plague was first worked out, the problem of estimating the varying incidence and fluctuations in the flea population has been of primary importance in all their studies.

Occasionally individual rats are seen to harbour unusually large number of fleas. In a rat-flea survey of Madras Presidency (King *et al.* 1929) there were several records of rats—*Rattus rattus* harbouring 29-30 *Xenopsylla cheopis*, the maximum number of fleas of all species on any rat in that survey being 70. Even higher number of fleas have been recorded by the plague commission (1906) on rats dying of plague in Bombay. On one occasion 80 were recovered from a dying rat and in another case about 300 were recorded from three dead rats.

In the present studies rat-flea survey of a village Risima in Gondia district of Maharashtra State in India was conducted from 10-viii-65 to 21-viii-65. Rats were trapped in wonder traps and the fleas were collected from the live rats by brushing their body with a wire brush.

153 rats were collected out of which 148 were *R. rattus.* 1196 fleas all *X. cheopis* were collected from these rats. Rat density of this area was found to be 36·5 and the flea index 7·0.

Out of 1196 fleas recorded 676 fleas as detailed in the table below were recovered from 5 young rats of *R. rattus* all trapped in one trap from a single house of *Kucha* construction with mud tile roofing. The entire area of the house was about 300 sq ft with an open space near it where the house owner kept his bullock cart and two oxen and a cow.

TABLE

SHOWING THE NUMBER OF FLEAS RECOVERED FROM FIVE *R. rattus*

Sex		Weight in gm	Number of fleas recovered
♂	..	22	119
♀	..	20	128
♀	..	21	142
♀	..	28	84
♀	..	32	203

Such unusual occurrence of large number of fleas on individual rats though exceptional and rare is likely to occur during the peak of a severe rat epizootic when the rodent population in an area is decimated by plague resulting in an unusual concentration of ectoparasites on the few remaining rats.

High *cheopis* index as in the present case where the area was free of plague for the last 20 years has also been recorded in a village in Hawaian Island in U.S.A. which had remained free of plague infection during the 12 years of plague in the vicinity. In this village over 1000 *X. cheopis* were collected from 25 rats all trapped in the same locality (Eskey 1934).

In the present experiment it was interesting to note that 5 rats that yielded 676 fleas as per table were all young ones and further that they were trapped in the same trap from the same house and on the same day. This indicates that probably they were born in the same house as well.

Our thanks are due to Director, Haffkine, Institute for the facilities and to Shri M. L. Jaiswar and T. P. Masurkar for assistance.

DEPT. OF ENTOMOLOGY,
HAFFKINE INSTITUTE,
BOMBAY-12,
January 20, 1970.

G. C. CHATURVEDI
P. J. DEORAS

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15. A NOTE ON *ACANTHAGYNA DRAVIDA* (LIEFTINCK) [INSECTA: ODONATA: AESHNIDAE]

(*With a text-figure*)

While identifying a collection of Odonata from Calcutta the authors came across a male specimen of *Acanthagyna dravida.* This species was earlier reported by Laidlaw (1921) from Calcutta, but not by Fraser (1936), who worked extensively on Indian Odonates. The anal appendages of our specimen (Fig.) differ from the figure given by Fraser (1936), and they more or less agree with the description provided by Lieftinck (1960) based on specimens collected at Coorg. Moreover, our specimen differs from Fraser's description in having labrum olivaceous instead of ochreous brown, and

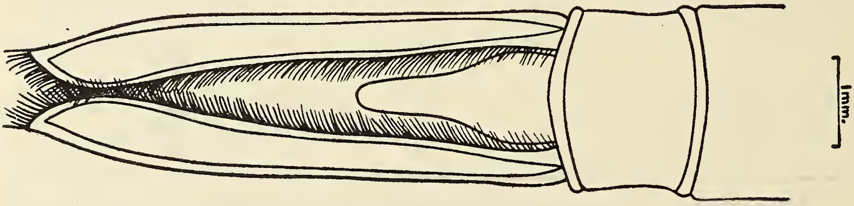

Fig. Anal appendages of the Calcutta specimen of *Acanthagyna dravida* (Lieftinck) ♂.

$$\text{nodal index } \frac{16-24/24-18}{16-16/18-17} \text{ instead of } \frac{17-24/25-17}{18-19/19-18} \text{ or } \frac{20-26/25-21}{20-18/19-21}.$$

Material examined:

1 ♂, Calcutta (at dusk), 30-viii-68, Coll. C.S. Roy.

The authors are thankful to Dr. M. M. Chakravarty, Head of the Department of Zoology, Calcutta University for laboratory facilities, Dr. D. E. Kimmins of British Museum (Nat. Hist.) for identification of the specimen and to Mr. C. S. Roy for the material.

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Calcutta-19,
December 23, 1969.

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16. A METHOD OF REARING SMALL POPULATIONS OF THE EPILACHNA BEETLE, *HENOSEPILACHNA SPARSA* HERBST IN THE LABORATORY (COLEOPTERA: COCCINELLIDAE)

Marcovitch (1937)[1] suggested the use of bean plants covered with 16-mesh screen wire cages for the mass rearing of *Epilachna corrupta* Mulsant and also recommended one-ounce tin salve box, whose bottom is covered with two pieces of moistened blotting paper for detailed studies of the life cycle of the beetle the feeding of which was done by supplying a fresh leaf daily. The authors have designed the following simple rearing cage for rearing small populations of the epilachna beetle, *Henosepilachna sparsa* Herbst successfully, throughout the year, for biological studies and experimental purposes.

A circular polystyrene plastic box, about 20 centimetres in diameter and about 6 centimetres in height and with a transparent lid is used for the purpose. On the top of the lid, two circular openings, each about 2 centimetres in diameter are made and these openings are covered with brass wire gauze of very fine mesh. The gauze can be securely fixed in position by heating and pressing it against the plastic surrounding the opening. These openings serve as adequate ventilators for the cage. A paste of Plaster of Paris in water is poured into the container to a height of about one centimetre and is allowed to set and dry thoroughly. The box is left in this state for about two weeks before use to prevent any possible chemical effect of fresh plaster on the beetles.

When the rearing cage is used, the plaster is damped by sprinkling some water on it and a fresh leaf of the host plant (in this case, *Datura fastuosa*) is placed inside the cage on a piece of plastic gauze of large mesh. This prevents direct contact of the leaf with the damp surface of the plaster which leads to rapid decomposition of the leaf. The beetles are then introduced into the cage which is then closed with the lid. The plaster holds the moisture well and provides a humid atmosphere inside the cage. It is moistened once in a week to maintain humidity. Fresh leaf is supplied each day and the cage is cleaned once in a week.

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[1] MARCOVITCH, H. (1937): *In* Culture methods for invertebrate animals. *Ed.* By Lutz, F. V., Welch, P. S., Galstoff, P. S. and Needham, J. G. Dover Publications, Inc. New York. pp. 590.

The beetles appear to thrive well under the above conditions. They feed actively and lay eggs either on the leaf or on the lower surface of the lid. The eggs or larvae may be transferred to other cages with the help of a camel hair brush moistened with distilled water, if necessary. Just prior to pupation, the late final instar larva moves to the lower surface of the lid and the pupa is then attached there and remains suspended until the time of eclosion. A uniform photoperiod of about 8 hours per day is provided to the beetles throughout the year during which, the beetles remain uniformly active. Some aspects of biology and behaviour of the beetles can be conveniently observed in detail through the transparent lid of the cage.

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August 1, 1969.

V. I. EDONA
A. B. SOANS

17. ON THE OCCURRENCE OF *CYCLOPELTA SICCIFOLIA* WESTW. (HEMIPTERA: PENTATOMIDAE) ON *ZIZYPHUS* SP. IN AURANGABAD

During an extensive faunistic survey of Aurangabad and adjoining areas (Maharashtra), the author came across a heavy infestation by the Pentatomid bug *Cyclopelta siccifolia* Westwood on twigs of ber, *Zizyphus* sp.

It has been reported earlier on *Pongamia glabra* and on pulses. Beeson (1941) in ECOLOGY AND CONTROL OF FOREST INSECTS listed 8 different hosts of the species. This is the first record of its occurrence on *Zizyphus* sp.

The bugs were congregated in groups with the individuals overlapping each other. When disturbed they made sluggish movements and emitted a pungent odour.

Material examined: 150 exs., Sta. No. 1, Lot No. 7. Godavari River Basin Survey, Aurangabad (Durg). 13-12-68. Coll. B.S. Lamba, Reg. No. A 459.

ACKNOWLEDGEMENT

I am grateful to Shri B. S. Lamba, Leader of the Godavari River Basin Faunistic Survey party and Officer-in-Charge, Western Regional Station, Zoological Survey of India, for providing facilities to examine the collections.

ZOOLOGICAL SURVEY OF INDIA, K. RAMACHANDRA RAO
WESTERN REGIONAL STATION,
POONA,
October 24, 1969.

18. OCCURRENCE OF *AMBLYOMMA JAVANENSE* (SUPINO, 1897) (IXODOIDEA : IXODIDAE) IN THE KYASANUR FOREST DISEASE AREA, SHIMOGA DISTRICT, MYSORE STATE, INDIA

Amblyomma javanense (Supino 1897) is widely distributed and is known from Pakistan, India, Ceylon, China and the South-east Asian countries (Anastos 1950). In India this species has been recorded from areas now included in West Bengal, Bihar, Maharashtra and Gujarat States (Sharif 1928). The known hosts of *A. javanense* include *Geomyda tricarinata*, *Varanus salvator*, *Python molurus*, *Vesperugo abramus*, *Manis pentadactyla*, *Hyaena hyaena* and *Nicoria tricarinata* (Anastos, op. cit.; Sharif, op. cit.).

During the course of the Epidemiological investigations of Kyasanur Forest Disease (KFD) in Shimoga District, Mysore State, India, thousands of Ixodid ticks belonging to 24 species (8 genera) including two species of *Amblyomma*, namely *A. integrum* and *A. testudinarium*, have been collected from forest vegetation and from various species of vertebrate hosts (Rajagopalan 1965; Rajagopalan *et al.* 1968; Trapido *et al.* 1964). However, *Amblyomma javanense* has not so far been recorded in this area.

We report the occurrence of *A. javanense* in KFD area, based on a small collection made at Karadigere forest on 16th June 1970. The identification of these specimens was confirmed by Dr. V. Dhanda. Two porcupines (*Hystrix indica*) were trapped after digging their burrow. One male *A. javanense* was collected from the body of a porcupine. After a careful examination, one questing nymph and two adults were found inside the burrow. The other species of ticks collected as ectoparasites from the same porcupines were, *Haemaphy-*

salis spinigera, *H. turturis* and *H. kyasanurensis*. The occurrence of questing nymphs and adults in the burrow indicates that this may not be a one host tick, as suggested by Anastos (1950).

We are grateful to Dr. H. R. Bhat for his valuable suggestions.

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I. C. M. R.,
POONA-1,
August 7, 1971.

M. A. SREENIVASAN
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19. A NEW HOST OF *ALECTRA PARASITICA* A. RICH. VAR. *CHITRAKUTENSIS* M. A. RAU

Alectra parasitica A. Rich. var. *chitrakutensis* M. A. Rau was described in 1961. It is an important medicinal plant and has hitherto been known to grow only on the roots of *Vitex negundo*. We record here, probably for the first time, *Ocimum sanctum* L. as another host.

The infested plants of *Ocimum sanctum* L. 'Rama Tulsi' were seen growing in sandy loam, un-manured, soil in the compound of a private building in Chitrakut, U. P. The plants are irrigated frequently but lightly. They receive sun for about 5-6 hours during the winter and 7–8 hours during the summer months. The approximate age of the plants is five years. The agency and the time of infestation is not known. Apparently there is no difference in the health of the infested and the non-infested plants growing side by side. The parasite has been seen in flower in December, 1970.

Occurrence of the parasite on this new host may be of medicinal interest also. In this context it may be mentioned that both the host plants viz., *Vitex negundo* and *Ocimum sanctum* are important medicinal plants themselves and belong to two different families. It may be possible that the rhizome of the parasite growing on these two plants differ in chemical composition and medicinal properties.

The specimen sheet has been lodged in the herbarium of the National Botanic Gardens, Lucknow (Coll. Srivastava and Shukla–84601).

Authors are grateful to Dr. L. B. Singh, Director, National Botanic Gardens, Lucknow, for providing necessary facilities.

National Botanic Gardens, G. S. SRIVASTAVA
Lucknow, D. S. SHUKLA
January 5, 1971.

20. A NOTE ON GROWING NIRGUNDI, *ALECTRA PARASITICA* A. RICH. VAR. *CHITRAKUTENSIS* M. A. RAU AT LUCKNOW

Nirgundi has been used for centuries in the indigenous systems of medicine in the treatment of leprosy. The plant was earlier identified as *Alectra thomsonii* (Raizada 1955; Rau & Rao 1959). Later Rau, 1961 named it as *Alectra parasitica* A. Rich. var. *chitrakutensis* M. A. Rau.

In recent years considerable interest has been taken in this drug. Studies have been made on its availability, chemistry and therapeutical effectiveness (Bedi 1967, Prasad 1962, Rajagopalan & Seshadri 1964).

The plant has been known to have a restricted area of distribution in Chitrakut and its vicinity in the districts of Banda (Uttar Pradesh) and Satna (Madhya Pradesh). Saxena *et al.*, 1969, reported it also from Jabalpur and Chanderi-Guna in Madhya Pradesh. So far as the authors are aware, attempts made, if any, on growing the plant at places other than its natural habitat have not been fruitful. Bedi, 1967, has suggested trials to be made in growing Nirgundi in places other than its natural occurrence. An attempt was, therefore, made to see if the plant could grow and survive under the soil and climatic conditions prevailing at Lucknow. Some infested plants of *Vitex negundo* were dug up from Chitrakut area in February 1969. They were made light by pruning the shoots and also some un-infested roots. The roots bearing the parasite were not disturbed. These plants were packed in plastic sheet and brought to Lucknow. Immediately on arrival they were planted in sandy soil in an open situation in the garden. The beds were kept clean of weeds. Irrigation was given only during the summer months when the plants were lightly watered once a month. The plants of *Vitex* sprouted and grew well but the parasite did not come up the ground during the following winter. Rhizomes of the parasite were, however, seen developing well beneath the ground. From August, 1970, shoots of *Alectra parasitica* started coming up the ground and producing flowers. The sprouting has continued since then.

This preliminary success in growing Nirgundi at Lucknow indicates that the plant has some flexibility with regard to soil and climatic requirements. The method of propagation and culture need study in greater detail for undertaking the cultivation of Nirgundi on a larger scale.

We are grateful to Dr. L. B. Singh, Director, National Botanic Gardens, Lucknow, for facilities.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
January, 12, 1971.

G. S. SRIVASTAVA
D. S. SHUKLA

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21. NOMENCLATURAL CHANGES IN SOME BOMBAY PLANTS—IV

(*Continued from Vol.* **66** : 233)

PAPILIONACEAE

Alysicarpus scariosus (Rottl. ex Spreng.) Grah. ex Thw. Enum. Pl. Zeyl. 88, 1858 (Type Wall. Cat. 5766 K); Ali in Biol. 12 : 32, 1966. *Hedysarum glumaceum* Auct. non Linn.; Roth, Nov. Pl. Sp. 355, 1821. *Hedysarum scariosum* Rottl. ex Spreng. Syst. Veg. 3 : 319, 1826. *Alysicarpus glumaceus* (Roth) Schindl. in Fedde Repert. Sp. Nov. 21 : 12, 1925, non DC. 1825; Shah in J. Bombay nat. Hist. Soc. 60 : 296, 1963; Santapau in Rec. bot. Surv. India 16 (1) (ed. 3) : 60,

1967. *Alysicarpus rugosus* var. *styracifolius* Baker in Hook. f. Fl. Brit. India 2 : 159, 1876 ; Cooke 1 : 348. *Alysicarpus styracifolius* DC. Prodr. 2 : 353, 1825 ; Santapau, Fl. Saurashtra 150, 1962.

In an earlier paper Shah (*J. Bombay nat. Hist. Soc.* 60 : 296, 1963) considered *A. glumaceus* Schindl. a valid name. However, from a critical study of the type specimen at Kew, Ali (1966) found that the Indian plant is not identical with *Hedysarum glumaceum* Linn. and, therefore, the name *A. glumaceus* is not valid. He, therefore, took up *A. scariosus* Grah. ex Thw. as the next earliest valid name.

Goniogyna hirta (Willd.) Ali in Taxon 16 : 463, 1967. *Hallia hirta* Willd. Sp. Pl. 3 (2) : 1169, 1803. *Heylandia latebrosa* DC. Mem. Leg. 6 : 201, 1825 ; FBI 2 : 65 ; Cooke 1 : 291 (Omne non *Hedysarum latebrosum* Linn. 1753).

Ali pointed out that the generic name *Goniogyna* DC. has priority over *Heylandia* DC. because *Goniogyna* DC. in *Ann. Sc. Nat. Paris* Ser. I, 4 : 91, was published in January, 1825 and *Heylandia* DC. in DC. Prodr. 2 : 12, November, 1825. Ali (1967) is of the opinion that the identification of *Hedysarum latebrosum* is at present obscure, and doubtless this species is not even remotely connected with *Goniogyna*. Hence he made a new combination *Goniogyna hirta* Ali, rejecting the earliest name *Hedysarum latebrosum* which is at least *nomen ambiguum*.

Crotalaria spectabilis Roth, Nov. Pl. Sp. 341, 1821 ; Ali in Biol. 2 : 26, 1966. *C. sericea* Retz. Obs. 5 : 26, 1789, non Burm. 1768 ; FBI 2 : 75 ; Cooke 1 : 319.

Medicago polymorpha Linn. Sp. Pl. 779, 1753. *Medicago hispida* Gaertn. Fruct. 2 : 349, 1791 ; Bailey, Man. Cult. Pl. 582, 1949 ; Wealth of India 6 : 312, t. 106, 1962. *Medicago denticulata* Willd. Sp. Pl. 3 : 1414, 1802 ; FBI 2 : 90 ; Cooke 1 : 307.

Milletia peguensis Ali in Kew Bull. 21 (3) : 489, 1968. *M. ovalifolia* Kurz in J. As. Soc. Bengal 42 (2) : 68, 1873 ; FBI 2 : 107, omne non *P. ovalifolia* W. & A. 1834. Cultivated in gardens in Bombay.

Pueraria lobata (Willd.) Ohwi in Bull. Tokyo Sci. Mus. no. 18 : 16, 1947 ; Verdocourt in Taxon 17 : 170-173, 1968. *Dolichos triloba* Linn. Sp. Pl. 726, 1753 p.p. *Phaseolus trilobus* (Linn.) Ait. Hort. Kew. 3 : 30, 1789, quoad nomen tantum. *Dolichos lobatus* Willd. Sp. Pl. 3 (2) : 1047, 1803. *Pachyrrhizus thunbergianus* Sieb. & Zucc. in Abh. Akad. Munch. 4 (3) : 237, 1846. *Pueraria thunbergiana* (Sieb. & Zucc.) Benth. in J. Linn. Soc. Bot. 9 : 122, 1865 ; Santapau, Fl. Saurashtra 171, 1962 ; Santapau & Janardhanan in Bull. bot. Surv. Ind. 8 (Suppl. 1) : 19, 1967.

Trigonella hamosa (Linn.) Willd. ssp. **uncata** (Boiss. & Boe) Townsend in Kew Bull. 21 (3) : 437, 1968. *Trigonella uncata* Boiss. & Noe in Boiss. Diagn. Pl. Or. Nov. Ser. II, 2 : 12, 1856 ; Shah *et al.* in J. Bombay nat. Hist. Soc. 65 : 262, 1968 ; Ali in Pakistan J. For. 17 (2) : 257, 1967.

CAESALPINIACEAE

Cassia senna Linn. Sp. Pl. 377, 1753 ; Brenan in Kew Bull. 13 : 243, 1959. *Cassia angustifolia* Vahl, Symb. Bot. 1 : 29, 1790 ; FBI 2 : 264 ; Cooke 1 : 423 ; de Wit in Webbia 11 : 289, 1955 (sp. excl. vel impefectae notae).

Brenan recognises two varieties of which the Indian plant is var. *senna.*

CUCURBITACEAE

Citrullus lanatus (Thunb.) Matsumara & Nakai in Cat. Sem. Hort. Bot. University 1920 : 38 (1920); Mansfied ex Thiret in Taxon 12 (1) : 38, 1968 ; Hara in Taxon 18 (3) : 347, 1969. *Momordica lanata* Thunb. Prodr. Fl. Cap. 13, 1794 & 36, 1807. *Citrullus vulgaris* Schrader ex Eckl. & Zeyh. Enum. Pl. Afr.-Austr. 279, 1836 ; FBI 2 : 621 ; Cooke 1 : 537.

COMPOSITAE

Goniocaulon indicum (Klein ex Willd.) Clarke, Comp. Ind. 236, 1876 ; Jeffrey in Kew Bull. 22 : 134, 1968. *Serratula indica* Klein ex Willd. Sp. Pl. 3 : 1642, 1803. *Goniocaulon glabrum* Cass. in Bull. Soc. Philom. 1817 : 34 ; FBI 3 : 377 ; Cooke 2 : 55 ; Santapau & Janardhanan Bull. bot. Surv. India 8 (Suppl. 1) : 28, 1967.

For the nomenclature of this plant see Jeffrey.

PLUMBAGINACEAE

Dyerophytum indicum (Gibs. ex Wight) O. Kuntze, Rev. Gen. Pl. 3 : 394, 1891 ; Rau in Bull. bot. Surv. Ind. 10 (Suppl. Checklist) ; addenda 1969. *Vogelia indica* Gibs. ex Wight in Calc. Journ. Nat. Hist. 7 : 17, 1847 ; FBI 3 : 481 ; Cooke 2 : 79 ; Santapau & Janardhanan in Bull. bot. Surv. Ind. 8 (Suppl. 1) : 29, 1967. *Vogelia arabica* Boiss. ; Dalz. & Gibs. Bombay Fl. 220, 1861.

The generic name *Vogelia* Lamk. (1792) used in the Indian Floras is a later homonym of *Vogelia* J. F. Gmelin 1791. Such names are illegitimate according to Art. 64 of the Code. *Dyerophytum* O. Kuntze is, therefore, a valid generic name for the present plant.

BORAGINACEAE

Heliotropium ellipticum Ledeb. in Eichw. Pl. Casp.-Cauc. 6 : 10, 1830-33 ; Rau in Bull. bot. Surv. India 10 (Suppl. 2) : 51, 1969. *Heliotropium eichwaldii* Steud. Nomencl. ed. 2, 1 : 744, 1840-41, ex DC. Prodr. 9 : 535, 1845 ; FBI 4 : 149 ; Cooke 2 : 210.

The nomenclatural change is covered by the Rule of Priority. *H. ellipticum* Ledeb. (1830-33) has a priority over *H. eichwaldii* (1840-41 ex DC. 1845).

Heliotropium subulatum Hochst. ex DC. Prodr. 9 : 528, 551, 1845 ; Wealth of India 5 : 31, t. 20, 1959. *Heliotropium zeylanicum* Clarke in FBI 4 : 148, 1883 ; Cooke 2 : 207 omne non Lamk. 1789.

The plant *H. zeylanicum* is attributed to Lamarck (1789) in most of our Indian Floras but it is not identical with the Lamarckian species and, therefore, it automatically becomes invalid according to Art. 64 of the Code, it being a later homonym.

SOLANACEAE

Lycopersicon lycopersicum (Linn.) Santapau & Janardhanan in Bull. bot. Surv. India 8 (Suppl. 1) : 35, 1967 ; Raizada in Ind. For. 94 (6) : 445, 1968. *Solanum lycopersicum* Linn. Sp. Pl. 185, 1753. *Lycopersicon esculentum* Mill. Gard. Dict. ed. 8, no. 2, 1768. FBI 4 : 237 ; Cooke 2 : 275.

Raizada (1968) attributes the combination *Lycopersicon lycopersicum* to Karsten, *Deutsch.* Fl. 966, 1880-1885, but this is certainly incorrect since he made the combination *Lycopersicon lycopersicum* which is clearly an illegitimate one as being tautonym (See Art. 23 of the Code, 1966). Santapau in the checklist of Saurashtra Plants, therefore, published this name as a new combination.

Solanum erianthum D. Don, Prodr. Fl. Nep. 96, 1825; Roe in Taxon 17 : 177, 1968. *Solanum verbascifolium* Auct., non Linn. 1753 ; FBI 4 : 230 ; Cooke 2 : 203.

Roe K. E. states in summary ‘ The common unarmed pantropical species of *Solanum* known as *Solanum verbascifolium* L. must be called *S. erianthum* Don. The Linnean type specimen of *S. verbascifolium* is no. 248·1 of the Linnean Herbarium (Linn.) and belongs to prickly subgenus *Leptostemon.*

SCROPHULARIACEAE

Mimulus strictus Benth. Scrop. Ind. 28, 1835 ; Rau in Bull. bot. Surv. Ind. 10 (Suppl. 2) : 56, 1969. *Mimulus gracilis* auct. plur. non R. Br. 1810 ; FBI 4 : 259 ; Cooke 2 : 287.

The nomenclatural change is covered by Art. 64 of the Code.

LABIATAE

Basilicum polystachyon (Linn.) Moench. Meth. Suppl. 143, 1802 ; O. Kuntze Rev. Gen. Pl. 2 : 512, 1891 ; Bennet in Ind. For. 95 (9) : 629, 1969. *Ocimum polystachyon* Linn. Mant. 2 : 567, 1771. *Ocimum tenuiflorum* Burm. f. Fl. Ind. 129, 1768 (non Linn. 1753, *quoad est O. sanctum*). *Moschosma polystachyum* (Linn.) Benth. in Wall. Pl. As. Rar. 2 : 13, 1940 ; FBI 4 : 612 ; Cooke 2 : 445 ; Mukerjee in Rec. bot. Surv. Ind. 14 : 35, 1940.

For a nomenclatural discussion see Bennet (1969).

Salvia santolinaefolia Boiss. Diagn. Pl. Orient. 1 : 13, 1842 & Fl. Orient. 4 : 632, 1849 ; FBI 4 : 656 ; Mukerjee in Rec. bot. Surv. Ind. 14 : 108, 1940 ; Rau in Bull. bot. Surv. Ind. 10 (Suppl. 2) : 64, 1969. *Salvia pumila* Benth. in DC. Prodr. 12 : 356, 1848. *Salvia aegyptiaca* var. *pumila* Hk. f. in FBI 4 : 656, 1885 ; Cooke 2 : 474.

CHENOPODIACEAE

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EUPHORBIACEAE

Euphorbia chamaesyce Linn. Sp. Pl. 455, 1753 ; Wild, Weeds & Aliens in Africa 17, 1968. *Euphorbia prostrata* Ait. Hort. Kew 2 : 139, 1789 ; FBI 5 : 266 ; Santapau in J. Bombay nat. Hist. Soc. 46 : 380, 1946 & Bull. bot. Soc. Bengal 8 : 16, 1955.

Professor Hiram Wild of University College of Rhodesia, in his inaugural lecture given in the University College of Rhodesia on ‘ Weeds and aliens in Africa ’ treats *Euphorbia chamaesyce* Linn. and *E. prostrata* Ait. as conspecific, and has accepted the former name.

Euphorbia orbiculata H. B.K. Nov. Gen. Sp. 2 : 52, 1817 ; Rajgopal & Panigrahi in Taxon 17 (5) : 547, 1968. *E. microphylla* Heyne ex Roth, Nov. Pl. Sp. 229, 1821 (non Lamk. 1788). *Euphorbia bombaiensis* Santapau in Bull. bot. Soc. Bengal 8 : 17, 1955.

For a detailed discussion on nomenclature see Rajgopal and Panigrahi (1968).

PANDANACEAE

Pandanus odoratissimum Linn. f. Suppl. Pl. 64, 1781 ; St. John in Taxon 12 (5) : 201–204, 1963 ; Stone in Gard. Bull. Singapore 22 : 236, 1967. *Pandanus fascicularis* Lamk. Encycl. 1 : 372, 1783 ; FBI 6 : 485. *Pandanus tectorius* Soland. ex Parkinson in Journ. Voy. H.M.S. Endeavour 46, 1774 ex Warburger in Pfreich. 3 : 46, 1900 ; Cooke 2 : 814.

It is now agreed that the name *Pandanus tectorius* Solander ex Parkinson is not validly published (See Airy Shaw in Taxon 11 (7):223, 1962) and, therefore, dates only from Warburg's publication in 1900.

CYPERACEAE

Scirpus brachyceras Hochst. ex A. Rich. Tent. Fl. Abyss. 2 : 496, 1851. *Scirpus corymbosus* sensu Clarke in Fl. Brit. Ind. 6 : 657, 1893 ; Cooke 2 : 892 (non Linn. 1753, non Heyne ex Roth, 1821).

This is an interesting plant from the view point of nomenclature. The name *Scirpus corymbosus* Heyne ex Roth is antedated by *Scirpus corymbosus* L. [= *Rhynchosopra corymbosa* (L.) Britt.] and, therefore, illegitimate. Dr. Kern (in a personal communication) wrote to us that the African *S. brachyceras* Hochst. ex A. Rich. is so near to the Indian plant that its conspecificity with it can hardly be doubted and the earliest epithet *brachyceras* has to be accepted for the African plant and the Indian one. We have accepted the opinion of Dr. Kern in accepting *S. brachyceras* Hochst. ex A. Rich. as a valid name for the Indian plant.

DEPARTMENT OF BOTANY,
SARDAR PATEL UNIVERSITY,
VALLABH VIDYANAGAR,
(GUJARAT),
February 16, 1970.

G. L. SHAH
D. V. YOGI

22. ON THE ABUNDANT OCCURRENCE OF *ISCHAEMUM MANGALURICUM* (HACK) STAPF EX C. E. C. FISCHER IN MAHARASHTRA STATE

During field collections undertaken mainly in connection with the cytogenetic investigations on Indian grass species of the tribe Andropogoneae, a population of *Ischaemum mangaluricum* was found to grow in abundance in large and low lying paddy field in which water was flowing from a spring situated on one of its sides. This area was near the Octroi Naka at Amboli in Ratnagiri district. Fischer (1934) has recorded this species in South Canara, Mysore and Malabar and Bor (1960) has given the distribution of this species in Madras State and Ceylon. Cooke (1908) and Blatter & McCann (1935) have not recorded this species in the erstwhile Bombay Presidency. Hooker (1897) has however, observed that *I. aristatum* subsp. *imberbe* var. *mangaluricum* is found in Concan and Malabar.

Ischaemum mangaluricum (Hack) stapf ex C. E. C. Fischer in Gamble, Fl. Madras, 1723 (1934).

I. geniculatum Hochst. in Hohenack., Pl. Ind. Or. no. 184 (1847) *I. aristatum* (Hack non Linn.) subsp. *imberbe* var. *mangaluricum* Hack in DC.; Monogr. Phan. 6, 204 (1889), *I. aristatum* subsp. *imberbe* var. *fallax* Hack, loc. cit. 204.

An annual grass, culms 30-40 cm high, decumbent then ascending, leaves 10-15 cm long, linear, acuminate, glabrous, nodes glabrous, racemes 2, compressed, glabrous, 5-6 cm long, rachis fragile, trigonous glabrous, sessile spikelets 5 mm long, glabrous with large callus. Lower floret: male, anthers 3, lower glume slightly winged at tip, glabrous with 3-5 marginal nodules, coriaceous-crustaceous, yellow, lower lemma 4·5 mm long, hyaline, palea 4 mm long, not so strongly keeled. Upper floret: Hermaphrodite, anthers 3, styles 2, stigmas plumose, upper glume 5 mm long, strongly keeled, upper lemma 4 mm long, cleft half way down with or without own, palea hyaline. Pedicelled spikelets like sessile spikelets.

ACKNOWLEDGEMENT

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BOTANY DIVISION,
COLLEGE OF AGRICULTURE,
POONA-5,
June 16, 1971.

R. B. PATIL
R. D'CRUZ

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23. *TAGETES MINUTA* LINN. IN SIMLA HILLS

Tagetes minuta Linn., a native of South America, occurs in Simla Hills, and is not mentioned in the published floras of the region, e.g. Collett's FLORA SIMLENSIS (1921 ed.). This species was reported to be under cultivation in the garden of the Forest Research Institute, Dehra Dun, in 1922 and is also known to occur in some parts of the N.W. Himalayas, such as Joshimath, North Garhwal, U.P.; Sahya, near Chakrata; Neerath, H.P.; Tuini, Chakrata Forest Division, etc. The cultivated species in Indian gardens, namely *Tagetes erecta* Linn. and *T. patula* Linn. (Aztec or African and French Marigolds) are believed to have been introduced by the Portuguese with whom this plant appears to represent the *Rosa de ouro* or golden rose, which the Pope usually blesses at mass on a Sunday in Lent (Watt's DICTIONARY ECONOMIC PRODUCTS India **6** (3): 402-403, 1893). These species are quite naturalized in India and also commonly cultivated as garden plants. *T. minuta* Linn. appears to be a later introduction into India and is now quite naturalized at a number of places. Munz (*see* Robbins in *Univ. Calif. Agric. Exp. Sta. Bull.* no. 637: 103, 1940), and Munz and Keck (Calif. Flora 1160, 1963) reported this species as naturalized at Riverside, California, U.S.A., being collected there in 1921. The distinguishing features of the taxon are: annual, strongly scented herbs; leaves pinnate; leaflets linear-lanceolate, sharply serrate, conspicuously gland-dotted; heads numerous, inconspicuous, in crowded or congested cymes at the ends of branches; involucre *c.* 10×2·5-3 mm; florets obscure, extending only 1-2 mm out of involucre; ray florets 3-4, yellow; disc florets few, yellow; anthers gland-tipped. Flowering period: September-November. It is an aromatic herb and is suggested as fly and vermin repellant and also an effective larvicide killing maggots in wounds. Recent investigations on the screening of plant extracts of this taxon for biological activity have revealed its antiviral activity against Ranikhet disease virus and its effect on isolated tissues of guinea pig ileum (*Indian J. Expt. Biol.* 7: 260, 1969).

The specimens are conserved in the Herbarium of National Botanic Gardens, Lucknow (*Ram Singh* s.n., Herb. LWG) and the Medicinal Plant Herbarium, Central Drug Research Institute, Lucknow (*Mehrotra & Party*, no. 1144).

FLORISTIC BOTANY DIVISION,
NATIONAL BOTANIC GARDENS,
LUCKNOW,
August 21, 1971.

J. K. MAHESHWARI

24. PARASITISM BY THREE SPECIES OF *LORANTHUS* ON A SINGLE HOST PLANT

Parasitism by various species of *Loranthus* on different angiosperms as well as gymnosperms including numerous economic and horticultural taxa has been recorded from time to time from several states in India.

During a random survey of the parasites growing on plants in the arboretum of the Indian Botanic Garden, Calcutta, I saw on a variety (Red) of *Nerium indicum*, a sub-spontaneous ornamental plant of Apocynaceae grown at different divisions of the garden, three different species of *Loranthus* whose intensity of parasitism varied. The plant appears to be a new host record for all three parasites.

Parasite	Intensity of parasitism	Remarks
Dendrophthoe falcata (L.f.) Ettingsh. Syn. *Loranthus longiflorus* Desr.	Slight	Greatest damage to host
Macrosolen cochinchinensis (Lour.) V.T. Syn. *Loranthus ampullaceus* Roxb.	Moderate	Moderate damage to host
Loranthus ligustrinus Wall.	Very slight	Slight damage to host

ACKNOWLEDGEMENTS

The author wishes to record his sincere thanks and gratitude to late Rev. Dr. H. Santapau, F.N.I., ex-Director, Botanical Survey of India, for kindly suggesting this problem and thanks are also due to Dr. S. N. Mitra, Deputy Director, Botanical Survey of India, Indian Botanic Garden, Calcutta, for providing necessary facilities to carry out this work in the garden.

INDIAN BOTANIC GARDEN,
SIBPORE, HOWRAH,
July 16, 1971.

R. B. GHOSH

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25. *SOLIVA ANTHEMIFOLIA* JUSS. R. BR. EX LESS. (COMPOSITAE): AN ADVENTIVE SPECIES IN RAJASTHAN

The genus *Soliva* Ruiz et Pavon is represented by about 12 species, distributed mostly in Australia, South and Central America. Some species are reported to have naturalized in a few places in Australia, India and Java. In recent years, the species *S. anthemifolia* (Juss.)

R. Br. ex Less. [Syn. *Gymnostyles anthemifolia* (Juss.)] has been reported inland from near Ramnagar and Bahraich, Naipalgunge Road (Uttar Pradesh) by Bhattacharyya (in *Bull. bot. Surv. India* 5 : 375-376. 1963), and from Rispana, Dehra Dun, by Babu (in *Bull. bot. Surv. India* 8 : 201, 1967), and are the only records of its occurrence in India.

During the course of a botanical exploration of south-eastern part of Rajasthan, the authors collected some specimens of *S. anthemifolia* (Juss.) R. Br. ex Less. from the vicinity of Atru village in Kotah District. Here, the species is found in dry exposed situations along the banks of a tank situated at a distance of about 75 km to the east of Kotah on the Kota-Bina Railway Line, and its associates are *Trigonella occulta* Del., *Argemone mexicana* Linn., etc. Robert Brown (in *Trans. Linn. Soc. London* 12 : 101-102, 1817) observed this species only in cultivated grounds in the neighbourhood of Sydney (Australia), and states that it is a native of South America and was introduced in New South Wales from Brazil. In India, the species appears to be a recent introduction and is likely to establish on Indian soil. The distinguishing features of the taxon are: annual, prostrate herb; leaves alternate, pinnately dissected ; heads greenish-yellow, sessile, axillary ; ray florets female, without corolla ; disc florets tubular ; anthers obtuse at the base ; achenes flattened, winged, crowned by a hardened style.

The specimens have been deposited in the Herbarium of National Botanic Gardens, Lucknow (*V. Singh* 74760, LWG).

FLORISTIC BOTANY DIVISION,
NATIONAL BOTANIC GARDENS,
LUCKNOW,
July 8, 1971.

J. K. MAHESHWARI
VIJENDRA SINGH

26. *MERREMIA AEGYPTIA* (LINN.) URBAN—A NEW HOST OF *ALBUGO* IN THE INDIAN ARID ZONE AND ITS ECOLOGICAL IMPLICATIONS

During the course of the ecological studies in the Indian arid zone, a peculiar condensed morphogenetic transformation was observed on *M. aegyptia*, a convolvulaceous climber in Balsamand garden near Jodhpur. The apices of axillary branches at a number of places appeared condensed giving a complete hypertrophied structure of all parts. The stem had become swollen nearly ten times as compared to the unaffected one. The sepals were swollen, leathery and deformed without any distinction into petals and sepals. The growth of the infected branch having leaves and inflorescence became shortened immensely. On closer examination, white shining pustules of different sizes were seen which confirmed in the field itself that the fungus was a species of *Albugo*.

A large number of hosts both convolvulaceous and others on which *Albugo* species have been reported to be parasitic are on record (Damle 1943 ; Damle 1955). As far as the information of the author goes there has been no report of this fungus assuming such a condition in the arid zone, and there are reasons for it. A number of common plants which spring up in this desert after the first monsoon showers in July get infected by this fungus and show the asexual stage mostly on the leaves, but no sooner the rain goes, these rain-fed plants disappear and the development of the sexual stage is hardly achieved. In arid zone species like *Amaranthus*, the sexual stage is not seen commonly because of very thin leaves, although these stages have been seen in fleshy leaves of *Boerhaavia diffusa*, collected from Jaipur by us. Occurrence of *Albugo* is common and natural in places with high humidity or moisture which is essential for its growth and development. Occurrence of *Albugo* on a characteristic desert species like *M. aegyptia* and that too, much after the close of the rainy season in the month of December, is noteworthy.

Normally *Albugo* produces conidiosporangia early in the season when the environmental conditions specially in relation to moisture are favourable. The occurrence of both conidiosporangia as well as enormous number of oogonia and antheridia in the whole of the axis, is an adaptation for the survival of this parasitic fungus in the arid zone conditions. No systemic infection was seen anywhere except for the axillary shoot near the extreme end of the plant. No change in the habit of the whole plant was observed as reported in the case of *Ipomoea reniformis*, which has the trailing habit but became erect after the infection (Damle 1955). However, the infected axillary shoot exhibited a localised change from its normal habit.

It is possible that the absence of moisture under the prevailing conditions of this arid zone led to the simultaneous production of asexual and sexual stages which is abnormal.

The infected material was sectioned for the microscopic examination of the hypertrophied parts. Besides the conidiosporangia which were so profuse all over the surface subepidermally ; the oogonia, antheridia and the oospores were formed in abundance in different stages of development in axis and floral parts locally as a result of infection. It is to be emphasized again that the lack of parenchyma or palisade tissue caused a fewer number of perfect stages in leaves as compared to deformed and fleshy infected parts like the axis etc.

For the sake of comparison with other species, the measurements of conidisporangia, conidiosporangiophores, oogonia and oospores were made. Table 1 gives a comparative account of *Albugo* species collected on a few other convolvulaceous hosts.

TABLE 1

A COMPARATIVE ACCOUNT OF *Albugo* SPECIES ON CONVOLVULACEOUS HOSTS

Species	Conidiosporangia	Conidiosporangiophore	Oogonia	Oospores
Albugo on *M. aegyptia*	15-21 μ × 12-21 μ	51-90 μ × 15-27 μ	25-48 μ × 30-57 μ Undulating oogonial wall.	30-45 μ × 30-45 μ Nearly smooth walled.
A. ipomoeae penduranae (Schw.) Sw.	14-20 μ × 12-18 μ Equatorial thickening	—	Smooth oogonial wall oospore freely lodged.	25-55 μ Warty wall.
A. evolvuli (Damle) Safee and Thirum	13-15 μ × 11-13 μ No equatorial thickening	—	Warty wall, finally confluent with the oospore wall.	38-44 μ. More commonly 37-41 μ smooth wall.
A. pratapi (Damle)	12-16 μ × 14-20 μ No equatorial thickening	—	56-80 μ. Warty wall, confluent with oospore wall.	36-48 μ. More commonly 48-80 μ smooth wall.

A remarkable feature observed in the *Albugo* species presently collected is the comparatively smaller oogonia and oospores with bigger conidiosporangia from the ones so far recorded. This may be due to extraordinary ecological conditions where the plant grows. The above noted difference may be caused by the ecological conditions which might even lead to the development of a new species which a future study might reveal.

BOTANY DEPARTMENT,
UNIVERSITY OF JODHPUR,
JODHPUR (RAJ.), INDIA,
August 12, 1971.

D. N. SEN
M. C. BHANDARI

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27. *CUSCUTA CAMPESTRIS* YUNCKER: A NEW RECORD FOR WESTERN INDIA

While on a round in the experimental garden of the Botanical Survey of India at 7 Koregaon Road, Poona, on 17 May, 1971, I observed a species of *Cuscuta* Linn., belonging to the family Convolvulaceae, which on critical examination was identified as *C. campestris* Yuncker, a native of North America. The genus *Cuscuta* Linn. is widely distributed in Western India. Cooke (1905) in his Flora of the Presidency of Bombay has mentioned three species only, namely *C. reflexa* Roxb., *C. hyalina* Roth and *C. chinensis* Lamk. Santapau & Patel (1957) while revising ' The genus *Cuscuta* in Bombay ' have added a species *C. australis* R. Br. and a variety *C. chinensis* Lamk. var. *ciliaris* Engelm. Recently Santapau & Korlahalli (1965) reported *C. campestris* Yuncker as a new record for India from Dum Dum area of Calcutta, wherein they have included its nomenclature, description and illustrations. This is the second record of this species for India, and the first record for Western India. The species comes very close to *C. chinensis* Lamk. var. *ciliaris* Engelm ; but can be easily differentiated from the latter by its calyx lobes which are not carinated. It is a rare, slender, filiform, pale-yellow, parasitic twiner with pale-white flowers in many flowered compact clusters.

Flowers & fruits : May-June.

Herbarium specimens examined: *Singh* 112856 (*BSI*).

Hosts : The parasite was found growing on *Chrysanthemum indicum* Linn. (a garden plant) and *Oxalis corniculata* Linn. (a garden weed) two hitherto unreported hosts (Santapau & Korlahalli 1965).

ACKNOWLEDGEMENT

The author is thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona, for facilities and for kindly going through this note.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, 7 KOREGAON ROAD,
POONA 1,
June 17, 1971.

N. P. SINGH

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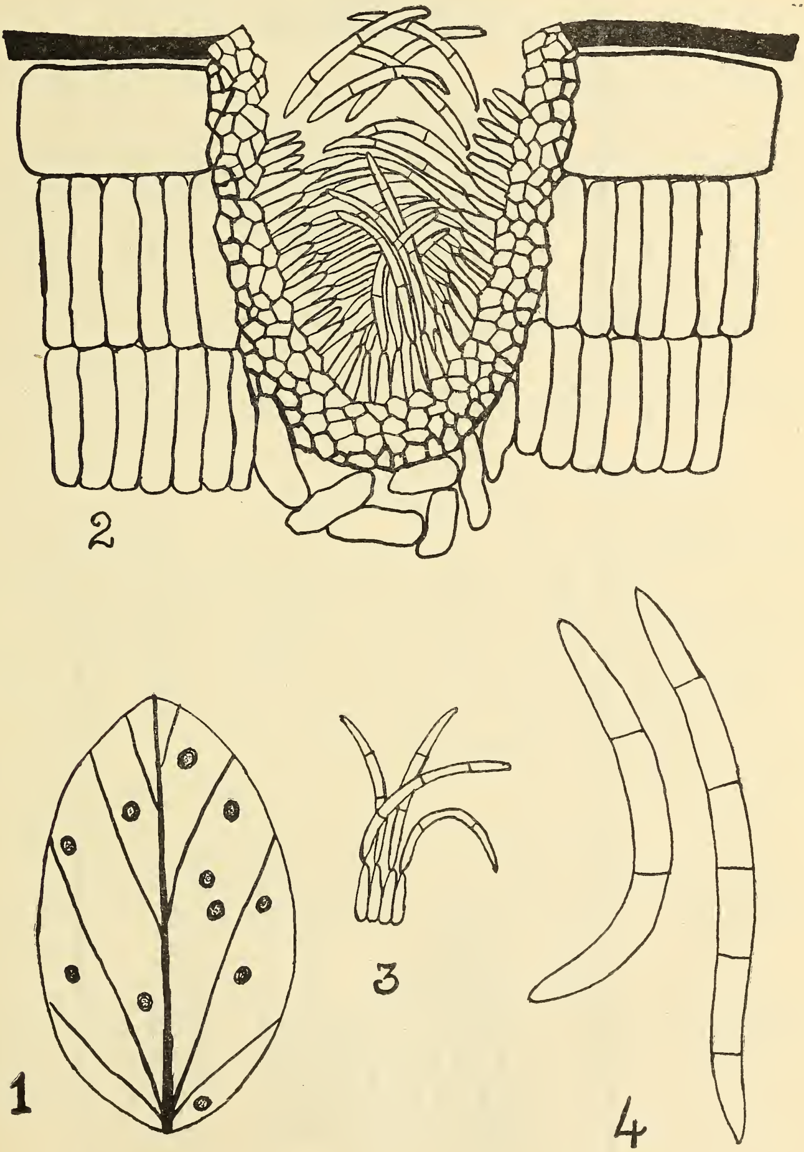
28. A NEW SPECIES OF *MICROPERA* FROM INDIA

(*With four text-figures*)

The fungus genus *Micropera* Lev. is represented in the Indian Flora by a single species *Micropera dahliae* Died. on *Dahlia variabilis* Desf. reported by Sydow & Butler (1916) from Pusa. Recently a fungus was collected



Figs. 1. Habit—Half natural size; 2. Section through pycnidium x 400; 3. Conidiophores and conidia x 400; 4. Conidia x 1000.

TABLE I

COMPARATIVE STUDIES OF DIFFERENT SPECIES OF *Micropera*

Species		Pycnidia	Conidiophores	Conidia	Locality
1. *Micropera rubida* B. et C.	..	——	——	——	North America
2. *M. drupacearum* Lev.	..	——	Up to 20 μ long	40-50 × 2-3 μ	Britain, Italy, America
3. *M. cotoneastri* (Fr.) Sacc.	..	350 × 400 μ	20-25 × 2·5 μ	15-16 × 0·75-2 μ	Germany
4. *M. padina* (Pers.) Sacc.	..	——	——	25-30 × 3·5-4 μ	Great Britain
5. *M. sorbi* (Fr.) Sacc.	..	——	——	15-16 × 1·75-2 μ	Arduennis
6. *M. betulina* Sacc.	..	——	——	18-20 × 3 μ	Arduennis
7. *M. decorticans* Lev.	..	——	——	——	Vogesis
8. *M. roseola* Lev.	..	——	——	——	Gallia (Ohio)
9. *M. tenella* Sacc.	..	——	——	25-30 × 2 μ	America
10. *M. pinastri* (Moug.) Sacc.	..	——	——	50-60 × 5-7 μ	Germany, Italy
11. *M. taxi* Sacc.	..	166-200 μ	——	50-60 × 3·5-4·5 μ	Italy
12. *M. versiformis* (A. & S.) Grove	..	——	——	25 × 6·5 μ	Shere (British Columbia) Highgate (Jamaica)
13. *M. turgida* (B. & Br.) V. Hohn	..	——	30 × 3 μ	20-30 × 4-5 μ	Great Britain
14. *M. spuria* (Fr.) V. Hohn	..	——	——	18-24 × 3 μ	Great Britain
15. *M. dahliae* Died.	..	Up to 150 μ in diam.	10-18 × ½ μ	20-25 × ½ μ	Pusa, India
16. *M. indica* sp. nov.	..	56-100 × 72-104 μ	8 × 3 μ	24-44 × 2.4-3.2 μ	Kolhapur (Maharashtra, India)

on the living leaves of *Ficus bengalensis* L. from Kolhapur. A critical study of literature (Saccardo 1884; Petch 1943; Barnett 1962) and comparison (Table 1) with the other known species revealed that the fungus under study differs in several morphological respects and the host is also hitherto unreported. It is therefore, considered as a new species.

Micropera indica sp. nov.

Infectionis maculae amphigenae, dispersae, circularea vel ovoidea, 1–4 mm in diam., margine fusce brunneo, centro pallidiore.

Stromata atrofusca, erumpentia, dispersa, pycnidia amphigena, singula, pezizoidea, immersa, irregulariter scisso ad apicem 56–100 × 72–104 μ, pariete exteriore atrobrunneo, interiore olivaceo usque hyalino.

Conidiophora brevia, simplicia, hyalina, non-septata, 8 × 3 μ.

Conidia hyalina, 3–6 cellularia, cylindraceo-fusoidea, curvata vel flexa, magnit. 24–44 × 2·4–3·2 μ.

Hab. In follis *Fici bengalensis* L., septembri anni 1970, ad Kolhapur, Maharashtra, leg. I. S. Pawar.

Micropera indica sp. nov.

Infection spots amphigenous, scattered, circular to ovoid, 1–4 mm in diameter, margin dark brown with pale leathery centre.

Stromata dark, erumpent, scattered, pycnidia amphigenous, solitary, cup-shaped, immersed, opening irregularly at apex, 56–100 × 72–104 μ, wall dark brown externally, olivaceous to hyaline internally.

Conidiophores short, simple, hyaline, non-septate, 8 × 3 μ.

Conidia hyaline, 3–6 cellular, cylindrically fusoid, curved or bent, measuring 24–44 × 2·4–3·2 μ.

Habit: On the living leaves of *Ficus bengalensis* L., September 1970, Kolhapur, Maharashtra, collected by I. S. Pawar.

The material has been deposited in the Botany Department, Shivaji University, Kolhapur and Mycology Division, M.A.C.S. Laboratories, Poona-4.

DEPARTMENT OF BOTANY,
SHIVAJI UNIVERSITY,
KOLHAPUR-4,
November 22, 1971.

I. S. PAWAR
U. K. KULKARNI

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The Crested Serpent Eagle

BY

S. M. OSMAN

Rarely is man so close to nature 'red in tooth and claw' as when he is confronted by an eagle on its kill. For there lies the natural food of the eagle, maybe a hare, a pheasant, or some other game that has met its end in violent death ; and crouching over it, with raised hackles and open beak, all the while flashing yellow eyes, a perfect picture of muscle and ferocity, sits the eagle. Such moments have always remained vividly etched in my mind, and I have also made it a point to record all my observations as soon as possible.

I am no specialist to count the number of mouthfuls that constitute an animal's meal, but I really have been a lifelong lover of eagles, seeking them out in the wild and training them for falconry, and I do hope these random recollections have some interest for readers of the *Journal.*

The first brush I ever had was with the serpent eagle (*Spilornis cheela*). These eagles have a conspicuous fan-shaped crest, short wings and heavily scaled legs. In size a crested serpent eagle may reach a length of twenty-five inches, though twenty-four is the normal size of an adult female bird. The bright yellow and bare skin on the face identifies it at a glance, and there can be no mistaking this bird for other eagles. Its deep yellow eyes, and grey-black beak, always show up in great contrast to the bare patches around the eyes. The crest feathers are almost black, with white bars running along the edges. The feathers on the back of the neck are dark brown with light edgings. Some birds have white spots on their wing-coverts, while others have faded edgings. Below and above the wings are banded with black bars. The tail is of a dark sepia colour tipped with a white band, and with wide median bands of pale buff running across it. On the breast will be seen feathers of a light sepia colour, barred with light cinnamon streaks. The greater part of the belly is generally of a cinnamon-brown shade, with white spots that persist down to the thighs. Because of the crested serpent eagle's extensive distribution, zonal colour differences are at times seen and generally birds from temperate zones are relatively paler than those that inhabit tropical forests with heavy rainfall.

The serpent eagle thrives in forested areas of the hills and plains skirting the Himalayas. In all my wanderings in the hills around Dehra Dun, I have not come across any serpent eagle at heights above six thousand feet though a friend of mine says he saw one at Benog some nine thousand feet above sea level.

The birds are nearly always seen near watercourses and streams, or soaring above marshy and swampy tracts. Lofty trees along the banks of streams and rivers provide ideal perches. Their food is mainly snakes, both poisonous and non-poisonous. Where there are not many snakes, or at seasons when snakes are hibernating, these eagles have been seen killing peafowl, junglefowl, and sometimes mammals as large as hares. They also rob other and smaller birds of prey.

I have very often seen the eagle devouring snakes in mid-air. A very large portion of its diet consists of snakes, and during the nesting season, when food for the young has to be brought in from long distances, the parent bird does not bring home the kill held in its claws, but swallows it first, leaving only a few inches of the tail sticking out of its beak. In this manner food is flown to the nest for the young. Once back in the nest the eagle regurgitates the snake for the young to eat. I once saw a serpent eagle attack and kill a cobra. The eagle lifted it off the ground but I think it was a bit too big for the bird to swallow, and the cobra was therefore carried home held in the claws. As the eagle flew down the ridge on which we sat, it happened to pass so close to us that I could very clearly see the yellow underside of the cobra and the steel blue of its upper portion as with each wing-beat the now dead snake oscillated from side to side. Occasionally frogs are also killed and eaten by this eagle, and when hard pressed I have noticed it feasting on crabs and insects as well. During the nesting season, the male bird is the more active of the pair. It has been noticed bringing food for the young as well as for its mate.

Whether the male shares the incubation of the eggs is not certain. From my observations I am led to believe that the arduous task of a sitter is entirely left to the female, and from what I could see she is a very close sitter. The nest is usually placed on a fork half-way or two-thirds up a tree. Of the several nests that I have seen, none was far from a stream or watercourse. Not unusually large, the nest consists mainly of twigs, sometimes lined with leaves. I once noticed a few tufts of grass, but this I think is unusual. I have never attempted to rob the nests that I have seen. Also I hate to disturb birds that are incubating for fear they may desert the nest, leaving the eggs to addle. The eggs, not more than two, are blotched with some shade of brown. During the mating season the eagles are always very noisy, and readily betray their presence by harsh screams and high-pitched four-noted yelps.

With the snows clearly showing on the hills, one winter afternoon some twenty-five years ago, I went out to watch the performance of a newly trained goshawk owned by my uncle. It was our intention to hunt along the Ahsan river in the western Doon valley at a place called Chanderbunny. Lately there had been *khubber* of a lot of junglefowl in the area. The place had apparently not been hunted much, and was known to abound in small and ground game. To the south of this place, skirting the cultivated expanse, there stood a belt of thick sal forest. Near the Ahsan, cultivated patches with hedgerows made ideal cover for grey and black partridge; and the banks of the Ahsan, with their luxuriant growth of thick bushes and reeds, harboured junglefowl, peafowl, an occasional hog deer, and sometimes chital as well. Since pig and deer of many kinds came down from the sal forest to drink at the river's bank, at times many a grunter could also be disturbed.

In the low jungle bordering the heavy sal forest, pheasants too could be had. It was along this belt that we spread out, Teddy the Irish setter quartering the ground in front of us. We had covered barely a hundred yards when the setter froze in a perfect point. Immediately, we all like soldiers moved into position. Teddy was coaxed into movement, and a black partridge exploded out of the bush with a tremendous whirr of wings. This being the goshawk's first attempt at capturing game since it had been trained, our plans had been carefully worked out beforehand. I saw my uncle slip the hawk immediately in a perfect cast. After a short determined dash the hawk caught up with the ill-fated partridge and everything seemed set for a perfect kill. But we had forgotten eagles. The goshawk and its quarry had barely landed on the ground when we saw an eagle approaching. As it passed close overhead I could see its wolfish greedy expression. Its yellow eyes, and the bare bright yellow facial skin were clearly visible. My cousin who led the party was carrying a shot-gun. I saw him take aim and fire at the eagle as it passed no more than twenty yards away from him. All of us were well acquainted with eagle savagery, and fully realized what would happen should the eagle reach the goshawk. The eagle fell after it had been hit, and when I ran to it, I found it alive, gyrating on the ground, still dizzy from the dose of lead it had received.

After the goshawk had been collected, and the black partridge put in the hunting bag, the rest of the party came over to where I was busy examining the eagle. By now it had sufficiently recovered and showed signs of activeness. Close examination had shown that a stray pellet had merely grazed the skull bone. So it had been the stunning blow of lead on this vital part that had brought the eagle down and kept it on the ground. As it was now rapidly regaining its faculties I grabbed its scaly legs, folded its wings as best I could, and tucked it under my arm. This way I hoped to carry my bundle home, but alas, ' man proposes and God disposes '. Though this was the first eagle I handled, I am unlikely to forget the part it played in my life on that fateful day. This being the goshawk's first day out in the field, no more flights were to be attempted that afternoon, so we decided to start back for home. On the way we were obliged to cross the Ahsan where a big tree had fallen across it, serving as a temporary bridge. I happened to be the last one to go across, and had nearly gained the other bank when I lost my balance. Not being able to use my left arm as a counterpoise, for this held the eagle, I fell to the right into the stream with a tremendous splash that almost knocked the breath out of my lungs and loosened my grip on the eagle. It flew off at once at great speed, as though a posse of devils were after it. I followed it with my eyes for a long distance, knowing that I had as much chance of getting my hands on it again as a snowflake in a bonfire.

A ducking in icy water at the end of a chilly winter's evening is not a very pleasant experience at the best of times. The loss of the eagle made it still more painful to bear. As I splashed out of the shallows, I simply could not understand the way all my companions kept laughing. Sympathetically, though still grinning very hard, my uncle said, ' Don't be too unhappy. It was only a serpent eagle, not used in falconry, and in any case all this stuff about hawks and eagles is bound to keep your mind off your studies, and you will have to go back to school in a few days.' I was obliged to grin and bear all this as best as I could, and to suppress many an angry retort. Some day, I thought, I am going to catch that bird again.

Almost a year later a man came to me and rather insolently said that he had an eagle for sale. He said he had brought the bird with him, and straightaway demanded fifty rupees for it. I told him I preferred to see the eagle first and fix the price afterwards. Thereupon he produced a large gunny sack, untied the neck and fished out an object which proved to be an eagle. It had been secured with bits of string, cord and leather thongs so mercilessly that it was impossible for it to make even the slightest movement. The bare yellow face, and short thick powerful toes with scales in place of feathers on the tarsus, made identification quite easy. There was no mistaking the serpent eagle. As I stood watching the unfortunate bird, so helpless and in such great agony, I decided to rescue it if I could from the clutches of the rascally birdcatcher, without of course in any way rewarding him. Aloud I said, ' This eagle is going to die very soon, and as far as I am able to make out, I fear that it has one wing broken or injured beyond relief. It cannot fly any longer and is of no use to me. Should it be able to fly even for a short distance, and this you will have to demonstrate, I will certainly give you fifty rupees for it.'

The fool swallowed the bait and the next moment found him busily engaged in uncoiling the leather thongs and bits of string that held the eagle. As soon as the cord fell away from its claws, the eagle grabbed the birdcatcher's hand. He let out a scream and dropped the bird. This loosened the last restraining strands of binding material and it immediately flew away to freedom. 'Quickly,' I said, 'run after the eagle and bring it back. I am prepared to let you have fifty rupees for it.' Nursing his injured palm, it slowly dawned on the birdcatcher how foolishly he had acted. He stood looking at me with hate written all over his face, and after giving me the dirtiest look he was capable of displaying, he walked slowly away, an angry and I hope a wiser man.

These encounters with the serpent eagle had been purely accidental, but at last I was lucky enough to have the opportunity of studying these birds very closely, in great detail and almost at will. In 1953, on my return from Afghanistan, I started work in the most famous and beautiful part of the eastern Doon jungles. It was mainly reclamation work close to the old Satyanarayan Temple that lies between Raiwala and Rishikesh. The area had once been cultivated. Sunken brick walls, fragments of a marble statue, and a disused well testified to a once flourishing village. No attempt had been made to restore the tumbledown village or the surrounding fields since Song Ji and Susuwa Ji (the two rivers that drain into the sacred Ganga) had decided, in one of their fits of turbulence more than eighty years ago, to burst their banks and carry away before them all impediments offered by man, the most foolish of God's creatures. Gone were the men who had so audaciously challenged the rivers and the wilderness. No more would be heard the conch of the pujari calling devotees to prayer. The simple village folk who dwelt not far from the ruins assured me that on some evenings one would still hear the wail of conches from where stood the tumbledown temple, while benighted shikaris, and fishermen on their way back to camp, sometimes heard the clash of phantom cymbals and the chanting of mantras, as shadowy forms foregathered on moonlit nights within the temple ruins.

I must admit that such wondrous sights and musical sounds were denied to me. On many a summer's evening I have sat till late in the night, but save for the occasional hoot of an owl, the drumming of a nightjar, the rustling of leaves in the breeze, and the most unmusical ping of mosquitoes, the silence was unbroken. Only rats scurrying about in the undergrowth conveyed the impression of lost souls bent on some unknown purpose. And I would continue to sit in the penetrating calm of the evening till, without any warning, from far within the government forest would be heard the tiger's call. Then would come the mocking call of the great horned owl, *bu-bu*, and deep in the forest a chital would bark and a sambar proclaim his love like some cracked bell. A train passing the station at Raiwala would whistle: the last train from Dehra I would think, with sleep-laden mind. That would be the signal for me to end my vigil. So have I waited patiently on many a night to watch the congregation of shadowy folk. Beautiful nights under a star-decked sky, or with the hunter's moon flooding the forest with light. In the hedges glow-worms flashed their tiny lamps, and far to the east Ganga Ji gurgling with pleasure flowed headlong to the sea.

In such lovely surroundings I was at the serpent eagle's door. Land reclamation was mainly confined to a strip roughly two miles broad and three miles long. On the western boundary, the tall trees of the government forest made an excellent windbreak. To the north the Song river, meandering, splitting into many channels, and joining again before mingling with the waters of the holy Ganga, showed the limit of our territory. To the south there lay the placid waters of the beloved Susuwa, reflecting the changing faces of the sky. The rushes growing thickly on either bank, trembling in the slightest breeze, and the pampas grass swaying in the wind seemed to convey a perpetual welcome to the visitor.

The whole country was full of big and small game, and was in consequence a veritable paradise to the naturalist. In addition to many other predatory birds, there was also a pair of serpent eagles. These birds I got to know intimately. On several occasions I was obliged to shoo them away from my peregrine falcon but they afforded me many happy hours of birdwatching. Only when the falcon was being flown did I not appreciate their company. They were always ready to chase the peregrine, whether as prelude to an attack or merely to drive it away from their territory, I am unable to say. It could have been both. The superior speed of the peregrine and her great manoeuvrability did not give the eagles much chance of success, but the encounter always left my falcon very much perturbed, and it would take me a long time to get her to stoop to the lure afterwards.

It was never very difficult to locate the eagles at any time of the day. I knew exactly where to look for them. They had established outposts all along the banks of the river Susuwa. Even when soaring, the eagles would announce their presence by repeated and persistent calls of *kek kek kee*. I have seen them take frogs from the many ponds in the area, and lizards, as well as snakes of many kinds. Only very rarely would the eagles swoop from the sky to capture their prey, in the manner of other hawks. They preferred to hunt by stealth and cunning. They would scrupulously observe nature's unwritten law of silent movement. Perseverance is their greatest asset. For many long hours, perched on some tree above a creek, or any other place where small rodents or snakes are likely to appear, the serpent eagle patiently watches and waits.

From this elevated platform, the moment it sees a likely prey, it stoops with amazing speed to capture its prize. Our eagles on the farm were quite unafraid of man and I could walk up to the tree they were perched on without alarming them in the least. Whenever the bulldozer was at work clearing virgin territory, the eagles would appear, attracted by the beat of the engine. They would take up positions on nearby trees and keenly watch the movements of the machine. When the blade of the dozer unearthed a nest of field rats, the eagles would dash after the poor scurrying creatures and would often fly triumphantly away with a rat dangling from their claws.

One day I witnessed a curious sight while clearing operations were in full swing. As I watched bushes being razed to the ground, three cobras jumped out of a demolished patch. One was immediately decapitated by the dozer's blade. Another one managed to glide to the safety of the closest bush. The third brute seemed to bear a charmed life. It crawled over the deadly blade and did not rest till it had gained a good seat on the bonnet of the machine. There with dilated hood it challenged the operator. Never have I seen anyone jump out of the driver's seat in greater haste. In a flash the driver was on the ground and the next instant I found him running like smoke. The dozer crept forward with the snake at the controls. Then for no apparent reason, the snake slid forward, fell off the bonnet and was immediately reduced to pulp under the tracks of the machine. Our friend the driver thereupon nimbly jumped to his seat and resumed command.

On one occasion I witnessed a most unusual display by one of the eagles. I was watching a pool in which small fish were jumping. A kingfisher repeatedly attempted to catch one of the leaping fish but did not seem to be having much luck. In its last attempt, it made a crash dive into the pool, and tried to leave the water by vigorously beating its wings as soon as it surfaced. While it was helplessly thrashing the water I saw an eagle come down like a bolt from the blue and snatch the ill-fated kingfisher. I think it was the female serpent eagle that thus carried off the kingfisher. The serpent eagle is comparatively a slow bird. It therefore watches and waits, and when it finds the prey at a decided disadvantage, it strikes.

The pool of water just mentioned used to be a favourite haunt of deer and peafowl, and I would amuse myself watching the visitors arrive and depart. This way I got to know most of the animals that came to the pool, some drank daily, and a few arrived precisely at the same hour every day. Peafowl mixed freely with the deer and I did not see any fight amongst the bucks either. Once however there occurred a very interesting incident. Some time previously I had disturbed a snake on the edge of this pool. The snake was almost brown in colour and as big as an ordinary cobra, and I thought it had come to the edge of the pool in quest of frogs. Therefore on this second occasion I was much surprised to find it surface right in the middle of the pool. With its head held high above the surface, carrying a small fish, not more than six inches long, in its mouth, it looked like a miniature Loch Ness Monster.

It was the first time I had seen a snake catch a fish, and I felt very pleased with my discovery. Later I was told that such a thing is not at all uncommon as even cobras are recorded to have taken to fishing at certain times. Not knowing much about snakes, I was at that time unable to label this one correctly, though I guess it could have been the common rat snake, plentifully available in the Doon valley. Had one of the eagles been around, I am sure some action would have followed. It would have been the case of snake eating fish and eagle eating snake—for such are the mysterious ways of Providence.

I once killed a Russell's Viper, and placed it in an open field directly in front of the tree on which one of our serpent eagles was perched. In less than five minutes the eagle had flown down to sample the offering but no sooner had it landed than it took off again. It did not even touch the dead snake. I have yet to know the reason for this extraordinary behaviour. That these birds take poisonous snakes is well established, so why was a dead viper not considered consumable ?

Years ago I tried to train a serpent eagle. To get it to jump to the fist was not all difficult, but try as I would I could never fully trust it with game. At first it would not even look at any live bird offered to it, and it was a very long time before it would grab a pigeon. I fear it would be almost impossible to make these eagles hunt birds instead of snakes. As Sadi said :

How can a man make a good sword from bad iron ?
An ignoble man becomes not, O Philosopher, noble by education.

An Ecological Survey of the larger Mammals of Peninsular India

BY

M. KRISHNAN

(*With forty-nine plates*)

[*Continued from Vol.* **69** (2) : 351]

THE CHINKARA
Gazella gazella (Pallas)

(Summary of field notes : Observation records : 5.
Locations : Andhra Pradesh—Kawal Sanctuary ; Bihar—Rehal, Karkatnagar ; Madhya Pradesh—Shivpuri National Park.
No photograph).

During the survey period no visits could be made to the ravine-cut plains jungles inhabited by chinkara, and no special attempt was made to see them except for a brief trip to Karkatnagar via Rehal. The Deccan, where I had seen chinkara prior to 1959, was not visited at all. I saw chinkara twice in Bihar during night drives, mere fleeting glimpses, and had a similar fleeting glimpse of a buck in Shivpuri, also during a night drive. I also saw them twice in the same forest in the Kawal Sanctuary, by day (A.P. 68 November 10 ; B 69 February 27 and March 2 ; MP 69 March 31).

Size : *Morphological characters*

Prater provides a full account of size and morphological characters.

Distribution

In the Kawal Sanctuary, I saw chinkara in heavier forests (teak forests) than they usually inhabit. The present distribution of the animal, when it has been so severely affected by hunting and is locally extinct in many of its former haunts, needs to be investigated.

THE BLACKBUCK
Antilope cervicapra (Linnaeus)

(Summary of field notes : Observation records : 30.
Locations : Tamil Nadu—Guindy Park, Point Calimere Sa.; Orissa—Bhetnoi near Aska ; Madhya Pradesh—Kanha N.P.
Photographs : TN 50, TN 57, MP 1, MP 39).

This is an animal whose disappearance from the plains forests of the South I have actually watched. In my boyhood it was common in the many stretches of scrub jungle around Madras, in small herds, sometimes in herds of over 50 : except in and around the Raj Bhavan at Guindy, where it is protected, it is now locally extinct in all these areas, and most of them have been reclaimed for agriculture, industrial enterprises, and other human purposes. Blackbuck in fairly large herds were known around the site of the Tungabhadra Project in the forties, but are now extinct there, having been shot out and snared.

Although this is a report which does not concern itself with past faunal history, it is necessary to briefly refer to the sustained massacre of blackbuck that has led to its present extinction in many parts of the peninsula, particularly in the Deccan and in South India.

Being an animal of the open plains, the blackbuck was most exposed to every form of hunting by every kind of hunter, for its haunts were often close to cantonments and barracks, small towns, and rural settlements. Everyone who has handled a gun in India within the past two centuries has probably shot blackbuck, for it was the commonest ' game ' animal and an animal whose hunting resulted both in a trophy (as often the skin of the doe as the horns of the buck) and in much-fancied meat. When sustained shooting made the buck wary of men, the hunters stalked their quarry under cover of a bullock cart, and later shot it from motor vehicles. Thousands of buck were shot every year, and more, perhaps, wounded. No Indian animal has suffered more at the hands of sportsmen.

When cultivation spread to the open scrub, an additional reason was found for shooting buck, as crop-raiders. Nor was the hunting of these animals limited to those with guns. Professional meat-hunters, using snares and similar devices, have probably accounted for more buck even than sportsmen. In fact, in the Tungabhadra area, it was the snare rather than the gun that finished off the local buck.

Nooses with slip-knots, usually made from the dried and stretched Achilles tendon of buck, were set staked to the ground in patches of the wild bitter-gourd, the fruit of which is greatly fancied by buck, and the animals caught by a foot were killed hours, may be even days, later. A specially cruel and effective means employed to immobilise blackbuck, practised all over the northern half of its range in the peninsula, is to insert a very sharp iron hook, something like a giant fish-hook, skilfully through the mark left by the stalk of a ripe bael fruit, so that it is entirely buried in the pulp within ; a thin, tough string, about 8 inches long, is attached at one end to this hook and the other end is tied to the middle of a sliver of hard-wood, shaped somewhat like a pencil and about the same length—the pencil and string are outside the fruit and the hook within. The bait is then left on the ground in areas known to be frequented by buck. The buck picks up the ripe fruit in its mouth and bites hard to get through the rind to the pulp within : this drives the point of the hook into its palate or the inside of a cheek, and instantly it paws at the pencil and string hanging out of its mouth with a forefoot, to get rid of the fruit which it cannot just spit out : this results in the pencil getting firmly lodged in the cleft between the hooves of the forefoot, and when this happens the devilish contraption succeeds in completely immobilising the animal, for every movement of the foot only drives the hook deeper in, and caught by its forefoot held to the mouth, it cannot use its muzzle to dislodge the sliver of wood from between the cleft in its hoof. It falls helpless to the ground, and then the hunter comes round in the course of his inspection of the grounds he has baited, and kills it.

Blackbuck are now extinct in most of the places where they were well known only 40 years ago, especially in the middle and south of the peninsula.

Long known to humanity in the plains, and notable for their beauty, grace and speed, blackbuck have separate names for the male and the female in most Indian languages. In Tamil, for instance, blackbuck are termed ' kalai-maan ' generally, and the buck is termed ' kalai ' and the doe ' pulvaai ' : Prater is at fault for once in giving some new-fangled Tamil name for blackbuck which seeks to distinguish between antelope and deer, a distinction that does not obtain in Indian languages.

Size : *Morphological characters*

Blackbuck are said to attain their best development in north India, in Rajputana and the Punjab. They are definitely smaller in size in the south-eastern part of the peninsula than in the central and north-western areas. The male is larger than the female and a big buck stands 32 inches high and weighs around 90 lb (Prater). Prater is incorrect in saying that in South India the adult buck are usually not black but a deep brown. In South India, too, the adult buck are a rich black as a rule, but a few adult males may remain a dark, grizzled colour.

The dark colour of the adult buck is notable, for it is largely diurnal and often lies up in the open during the hottest part of the day (MP 69 March 10).

Distribution

This exclusively Indian and prettiest of all antelopes had an all-India distribution in the plains till comparatively recently, inhabiting even the drier and more open scrub where many other animals with an all-India distribution (like the chital and the sloth bear) are not to be found. Being so heavily and systematically hunted, it has become locally extinct in most of its former haunts and its present distribution is scattered and in need of reassessment. It is now extinct in many of the black-cotton-soil tracts of the Deccan where formerly it was abundant, and also in most of its former haunts elsewhere in the peninsula. It inhabits coastal plains, along the eastern coastline, such as around Chilka Lake, Madras City and Point Calimere, but it is not to be found along the western coastline. It is basically an animal of the drier and more open plains scrub, and deprivation of territory by human occupation of its home has contributed as much as the gun or the snare to its decline.

Although man has been probably the most potent influence in the decline of blackbuck, it is significant that two of the major natural predators that used to inhabit its haunts along with it, the cheetah and the plains wolf, have both become extinct (the cheetah totally and the wolf locally) in those areas even ahead of the blackbuck.

Blackbuck do not inhabit dense forests or hilly country. An isolated population existed, or still survives in small numbers, immediately outside the Masinagudi area of the Mudumalai Sanctuary, on the north-eastern slopes of the Nilgiris where they flatten out into plains country.

Habits : Behaviour

It is noteworthy that in Bhetnoi near Aska in Orissa, rural sentiment has protected blackbuck for generations, although this is mainly an agricultural village. Inquiry of the villagers elicited the information that loss to crops from blackbuck was negligible : in Point Calimere, too, I was told that it was the pig and the chital that inhibited agriculture and not blackbuck. These instances will show to what extent a taste for buck-flesh lay behind the killing of blackbuck as crop-raiders all over India.

Besides short grasses and herbs, blackbuck eat a variety of creepers that spread along the ground in patches (such as *Ipomoea* spp.) and eat the foliage and fruits of many plants of the Cucurbitaceae. I have seen, necessarily from a great distance and through glasses, blackbuck scraping at soft soil with their forefeet and muzzle to get at the underground parts of some plant, and believe stolons, rhizomes and bulbs are also eaten. They drink regularly where water is available, as at Guindy Park, but seem to be able to do with little water where freshwater is scarce, as around Chilka Lake and at Point Calimere in summer.

Vision is the chief sense, and is very keen. Blackbuck have good night vision (TN 68 June 8) and are often abroad and feeding at night (MP 69 March 10, 70 March 12). However, they are mainly diurnal, and creatures of the sun. At night they lie down in groups in open ground where they cannot be surprised from cover, and piles of their droppings mark such resting places.

Blackbuck are the fastest long-distance runners in the world. Their habit of taking a few stiff-legged vertical leaps at the start of a run is well-known, and probably serves to enable them to see the country ahead before settling down to a bounding gallop. Once, I was in a motor vehicle kept going at top speed over very flat ground, and a herd of blackbuck kept easily ahead of us though we were going at about 40 mph, at times at 45 mph : after 3 miles we had to slow down as the ground became somewhat uneven, and the buck raced on ahead.

Jackals seem to be the chief predators that blackbuck have to contend with today. They take newborn and very young animals. These very young blackbuck are given to crouching, neck stretched in front (like barasingha) when approached : the mothers run away.

THE FOURHORNED ANTELOPE or CHOWSINGHA

Tetracerus quadricornis (Blainville)

(Summary of field notes : Observation records : 4.

Locations : Tamil Nadu—Mudumalai Sanctuary near Markundarai Betta ; Andhra Pradesh—Pakhal Sanctuary ; Bihar—Hazaribagh N.P.

No photograph).

The chowsingha, small-sized, localised, largely nocturnal and given to lurking in the undershrub of the forests it favours, was probably missed much oftener than seen during the survey period. It is one of those animals that one gets to know when residing in the area it inhabits, rather than during brief visits to such areas, and I know it well.

Size : Morphological characters

The chowsingha is roughly the size of a muntjac or a chinkara, about 26 inches high and weighing around 50 lb. The coarse, furry coat has a greyish tinge to its brown, distinct from the chestnut sheen of the muntjac, and it does not have the dishface and prominent black tail of the chinkara, but nevertheless, occurring as it does in forests where both these other animals are found, it is often mistaken for one of them, especially as colours are not clearly appreciated at night by artificial light.

This animal, which differs in certain anatomical particulars from other (true) antelopes, has more the habits of forest living deer than of antelopes, and is unique is being the only wild animal in the world with four horns : the does are hornless, but in the male, in addition to a pair of keeled spike horns on top of the head (where horns are normally located in antelopes) there is a pair of small horns just below, above the forehead, often reduced to mere horny buttons. Its nearest relatives are to be found in Africa.

Distribution

The chowsingha is uniquely Indian, and confined to peninsular India, somewhat capriciously distributed within this vast area in hilly tracts—it favours hilltops, particularly plateaus, and foothills, where there is plenty of grass and an assured supply of water : it is a thirsty animal and drinks regularly.

Habits : Behaviour

The chowsingha is usually seen by itself or in a pair, but occasionally in a party of from 3 to 5 or 6 (B 68 April 17). I saw the animal in April 1968 in the Hazaribagh National Park, but not in February 1969 and February 1970, though I kept a sharp lookout for it in both years. It could be the chowsingha shifts ground with the onset of summer, but they also seem, like muntjac, to remain more or less in the same forest area.

The chowsingha has quite exceptional leaping abilities.

THE NILGAI

Boselaphus tragocamelus (Pallas)

(Summary of field notes : Observation records: 12.

Locations : Andhra Pradesh—Eturnagaram Sa. ; Maharashtra—Taroba N.P.; Bihar—Hazaribagh N.P. ; Madhya Pradesh—Shivpuri N.P., near Mukhavlei, Bastar.

Photographs : MP 24, B 30).

Areas where nilgai are fairly common in Bihar and Madhya Pradesh were not visited during the survey period. No sustained observation was possible, all sight records being limited to fleeting or less fleeting glimpses, usually from a distance. A determined effort to observe or at least sight nilgai in the Kawal Sanctuary was unsuccessful (A.P. 68 November 7 to 11). Nilgai were seen, singly, in Eturnagaram and Taroba N.P. (A.P. 68 January 16 ; MR 68 November 18, 20; 69 November 17). A small herd of about 6, including a big bull was frequenting the sandy nullah near Pokharia gate in the Hazaribagh N.P., and some members of this party were seen thrice (B 69 February 8 and 14, 70 February 15 : photograph B 30) : nilgai seem fairly common in the Shivpuri N.P. of M.P. (MP 69 March 31 : photograph MP 24, April 3 and 4), and a party of 3 adult cows was seen in Bastar (MP 70 March 27). They were seen both by night and by day.

In view of the paucity of personal experience of nilgai, a note on it here is not justified. However, I may add that the description and depiction of the animal as having a short tail with a thick, black terminal tuft of hair is not quite correct. The short tail is dorso-ventrally flattened and the black hair grows thickly along the edges of the terminal third of the tail, forming a brush : the tail is raised vertically above the back under excitement.

THE HARDGROUND BARASINGHA

Cervus duvauceli branderi (Pocock)

(Summary of field notes : Observation records : 45.
Locations : Madhya Pradesh—Kanha National Park.
Photographs : MP 2, MP 13, MP 14, MP 19, MP 20, MP 21, MP 22, MP 27, MP 28, MP 31, MP 32, and MP 36).

The vulgar name provided here may be briefly explained. Since the name ' barasingha ' is also applied to the Kashmir stag or hangul, it may seem advisable to prefer the name ' swamp deer ' for both subspecies of *Cervus duvauceli*, as Prater has done. The name, while eminently applicable to the subspecies inhabiting marshy tracts in Uttar Pradesh and Assam (*C. duvauceli duvauceli*) seems misleading when applied to the subspecies found in Madhya Pradesh, and to qualify ' swamp deer ' with the adjectival ' hardground ' to distinguish *C. duvauceli branderi* is a literal contradiction in terms. Since this report is confined to the peninsula where only this last subspecies is found and where the Kashmir stag is not found, the name ' hardground barasingha ' seems specific and descriptive, and has been used.

Schaller provides an account of a detailed and deep study of this deer in the Kanha National Park (the area in which I observed it), and for this reason only a few observations need be detailed here.

Although smaller than the sambar and with quite distinctive antlers, and larger than the chital and with different antlers, I have known the barasingha confused with both in Kanha. From a distance visual assessment of size is not reliable, especially in open ground. The best way is to aid vision with glasses.

All barasingha seen in Kanha were observed in March 1969 and 70, and early in May 1968, when the stags had not yet shed their antlers here, and had ragged coats, with the hair of the winter coat coming off in matted strips and bunches. Some stags were dark brown in colour, a vandyke brown, but most were only a little darker than the hinds. Four stags lying down in the shade were attended on by crows, which plucked the hair off the neck of two stags in beakfuls, the stags offering no resistance to this attention : the crows were not using the matted hair for nesting, nor did they seem to have any object in indulging in this hair-stripping—they plucked out a beakful of hair, tossed it onto the ground, and then plucked out another beakful. After 7 or 8 beakfuls had been removed in this manner, both the stags tossed their antlers and chased away the crows (MP 70 March 13).

The stags seemed to have developed a certain brittleness of horn by March, about 2 months before shedding their antlers (late May-June). One stag had the right brow tine broken off clean at the base, where it joined the beam, a flat, oval, bone-white scar marking the cleavage

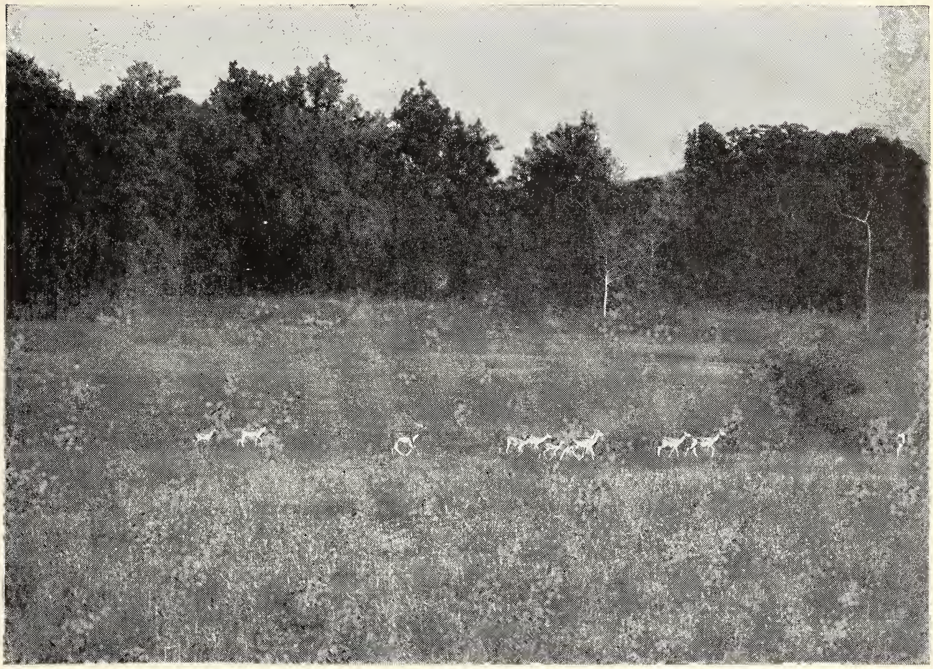
(MP 69 Mar. 13 : photograph MP 21) : another stag broke off a tine from the rack on top of the beam in between March 17 and 22, 1970, and had a similar flat, white, oval cleavage mark at the joint of the tine with the beam (MP 70 Mar. 23).

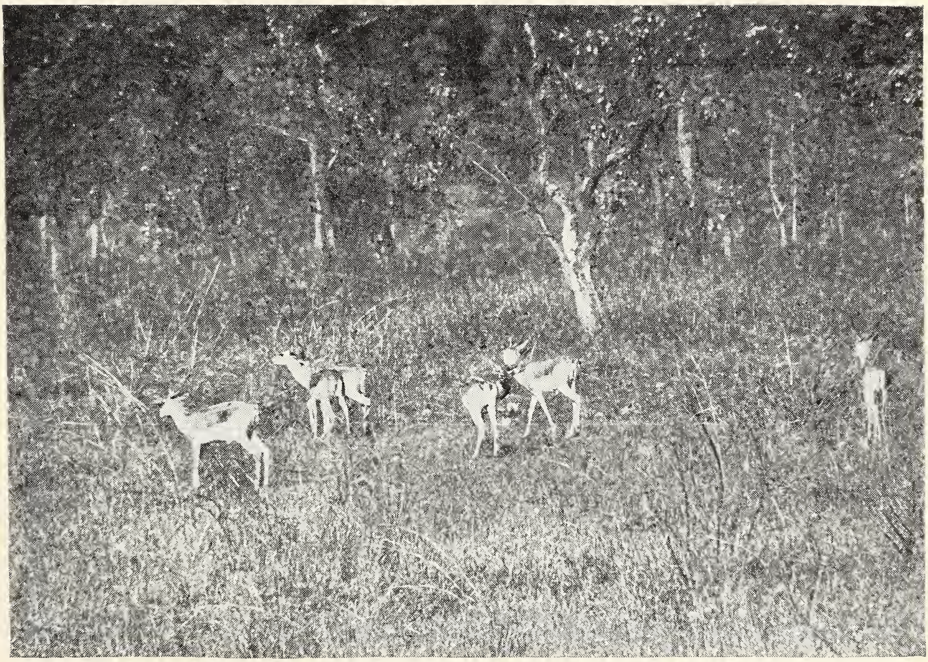
Although by March the breeding season is said to be over, one stag was seen displaying sexual interest in a hind, smelling at her hindquarters and smelling her urine and curling up the lips with the muzzle pointing up. No bugling was heard.

In March 1970 two big stags, not seen during previous visits to Kanha (in May 1968 and March 1969) were noticed. One was a 12-pointer with a coat only a little darker than a hind's and with well-developed antlers of the typical barasingha pattern, with the tines bone-white for their distal half : the other was a remarkable specimen, a little smaller in the body than the 12-pointer but sturdily built and dark brown, with rugged antlers, heavy enough and sufficiently beaded to have been notable on a sambar stag : the beam was rather straight, and the rack of tines on top numerous on somewhat palmate forks—the many snags made counting the total number of points difficult, though on several occasions he was closely observed, the difficulty being in determining what was a tine and what a mere burr or small snag : however, by any count this multipointer had upwards of 20 points (MP 70 Mar. 8, 12, 13, 19, 21, 22, 23 : photographs MP 27, MP 31 and MP 32—there are several other pictures of this multipointer taken to show his antlers from different angles in big blow-ups, which could not be included here because the details are not clear in small prints).

This multipointer was usually seen in the company of the big 12-pointer and sometimes along with two fully adult but lesser stags, a fine 10-pointer and a small, back-going 12-pointer, in a small stag-party of 4, and also in a herd with hinds, brockets, and young. The multipointer was obviously the most dominant stag in Kanha in March 1970 : the big 12-pointer took precedence after him, then the 10-pointer, then the 12-pointer : photograph MP 32 shows all the 4 stags together. No sparring between these stags was noticed, but once the two lesser stags locked horns for a few seconds in a desultory, brief bout of sparring. The head-up display was used by the two larger stags, towards the other two, and by the multipointer towards the big 12-pointer. It was noticed that when on the move both the big stags used a threat with the antlers lowered to direct a lesser stag in the lead. What can only be described as a sideway's glare was also used as a threat or direction : in chital, such ocular displays are common. Among hinds, too, the head-up display was freely used (MP 69 Mar. 16 : photograph MP 19), but no head-down display (used by chital and sambar stags in intimidation) was observed. Two hinds indulged in a mutual head-up display which was developed into their rising in the air on their hind legs and slashing

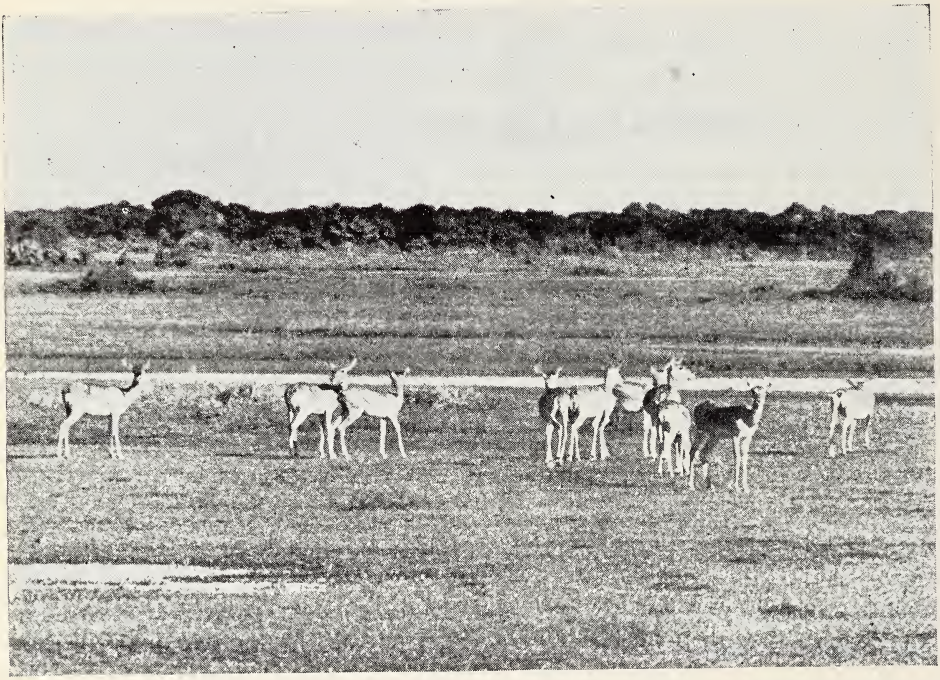
Krishnan : Mammals

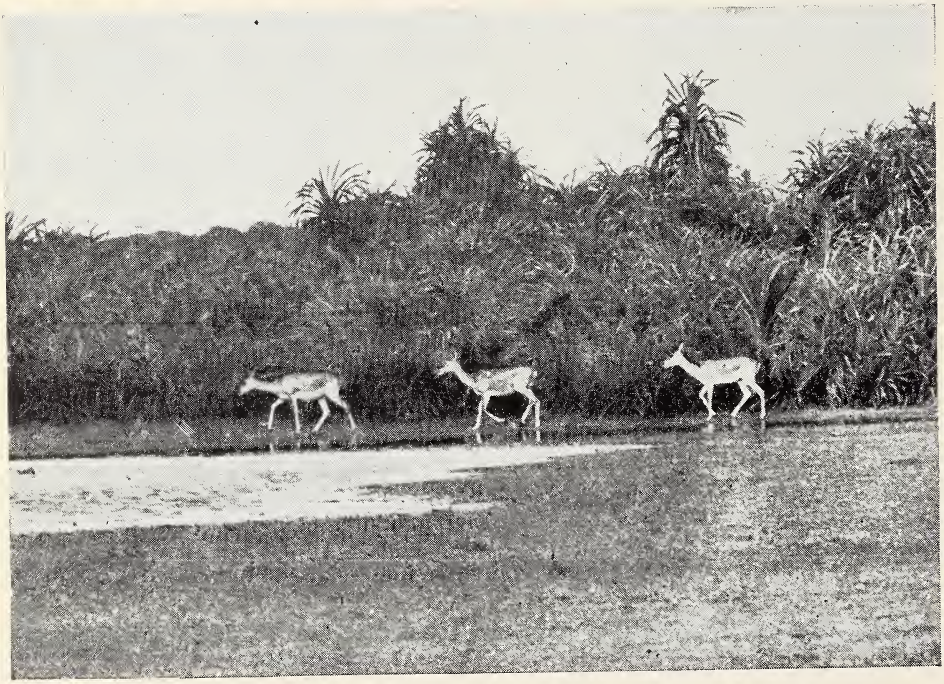




Above : M.P. 1968 : KANHA N.P. : May 1 — a.m. : A string of 11 blackbuck — MP. 1 ;
Below : M.P. 1970 : KANHA N.P. : March 22 — a.m. : The 6 male blackbuck — MP. 39.

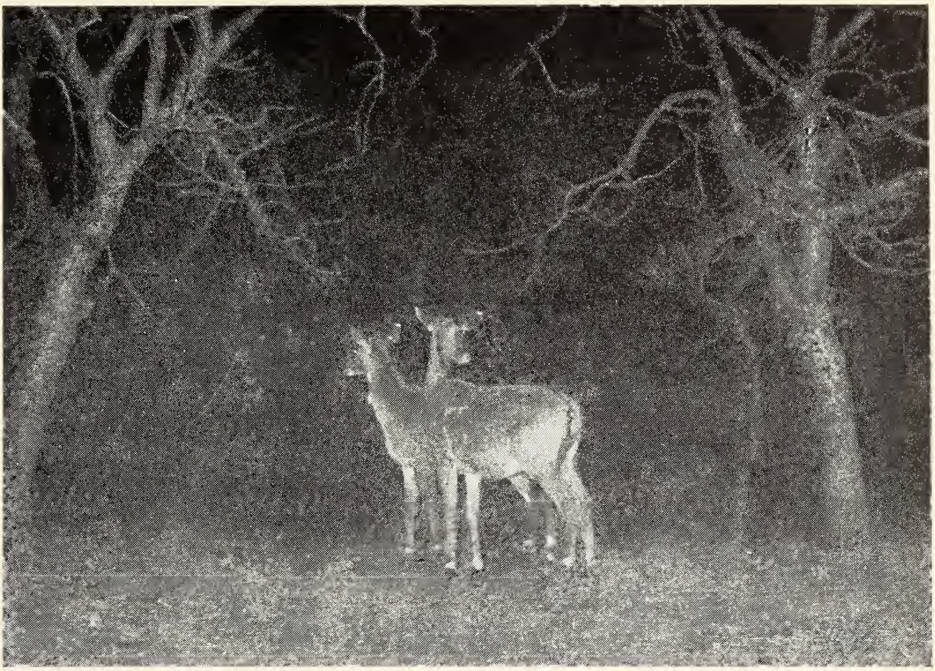
(*Photos : M. Krishnan*)

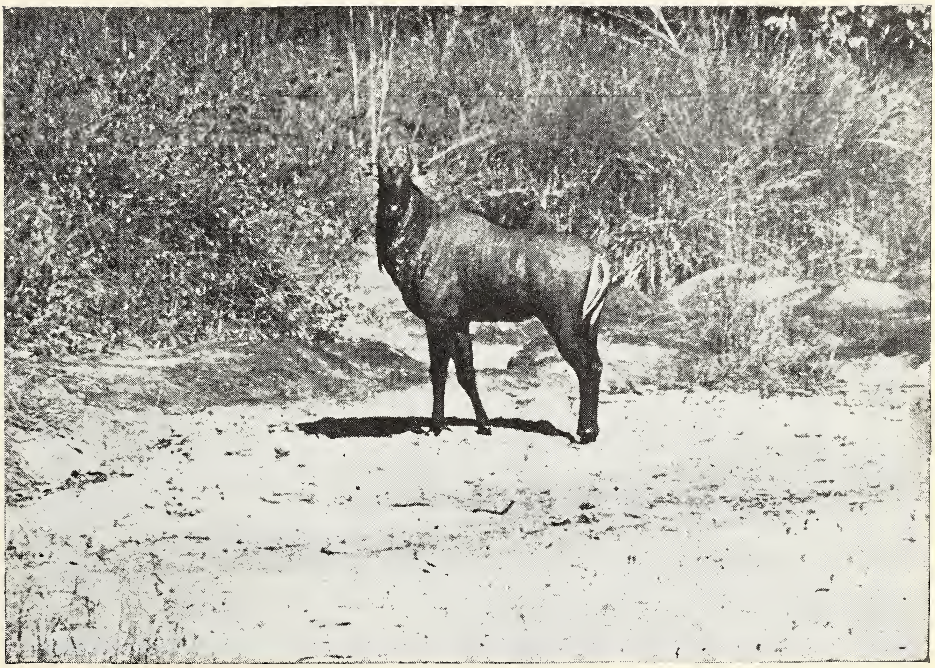




Above : TAMIL NADU 1968 : PT. CALIMERE : December 16 — a.m. : Blackbuck does — TN. 50 ; *Below :* TAMIL NADU 1969 : PT. CALIMERE : December 15 — evening : Blackbuck does against screwpine — TN. 57.

(*Photos : M. Krishnan*)

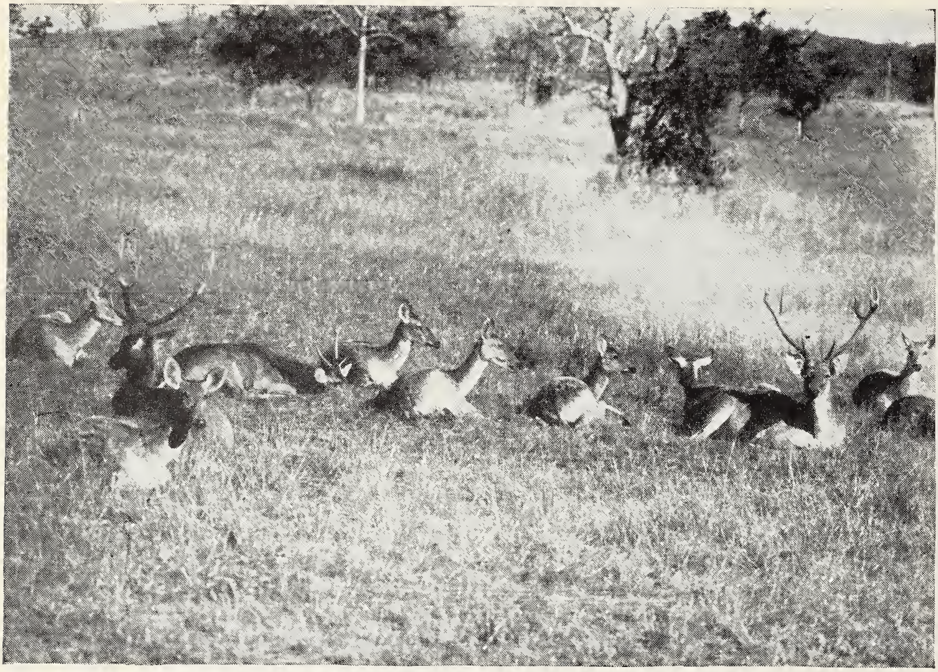




Above : M.P. 1969 : SHIVPURI N.P. : March 31 — 10 p.m. : Subadult nilgai bulls — MP. 34 ; *Below :* BIHAR 1970 : HAZARIBAGH N.P. : February 15 — about 3.30 p.m. : Bull nilgai — B. 30.

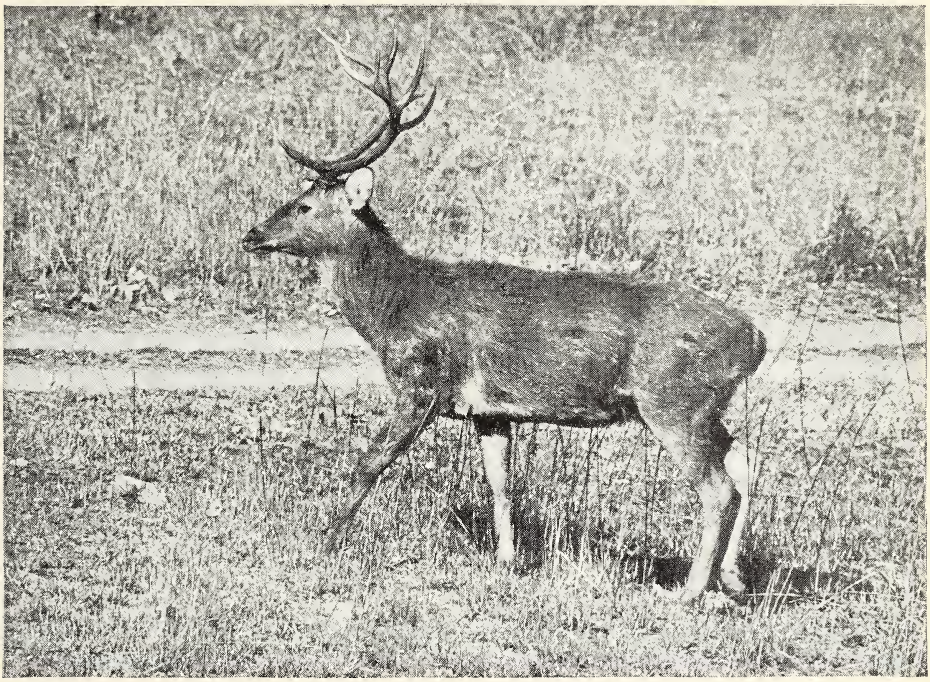
(*Photos : M. Krishnan*)

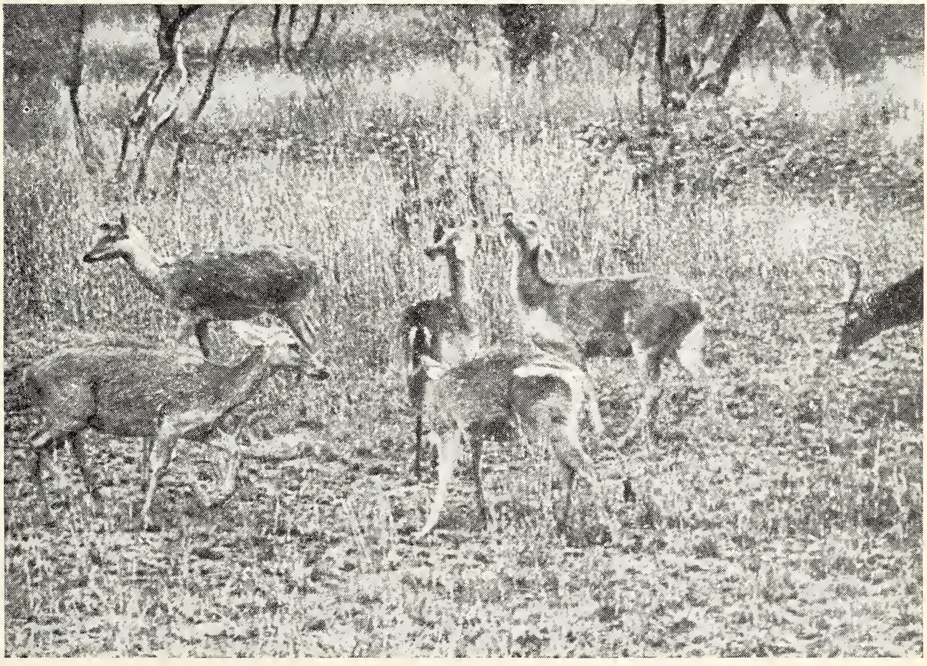
Krishnan : Mammals



Above : M.P. 1968 : KANHA N.P. : May 1 — a.m. : Part of a herd of barasingha lying up. Note two 12-pointers, and the brocket lying with neck outstretched — MP. 2 ; *Below :* M.P. 1969 : KANHA N.P. : March 8 — a.m. : Part of the herd of 47 barasingha — MP. 13.

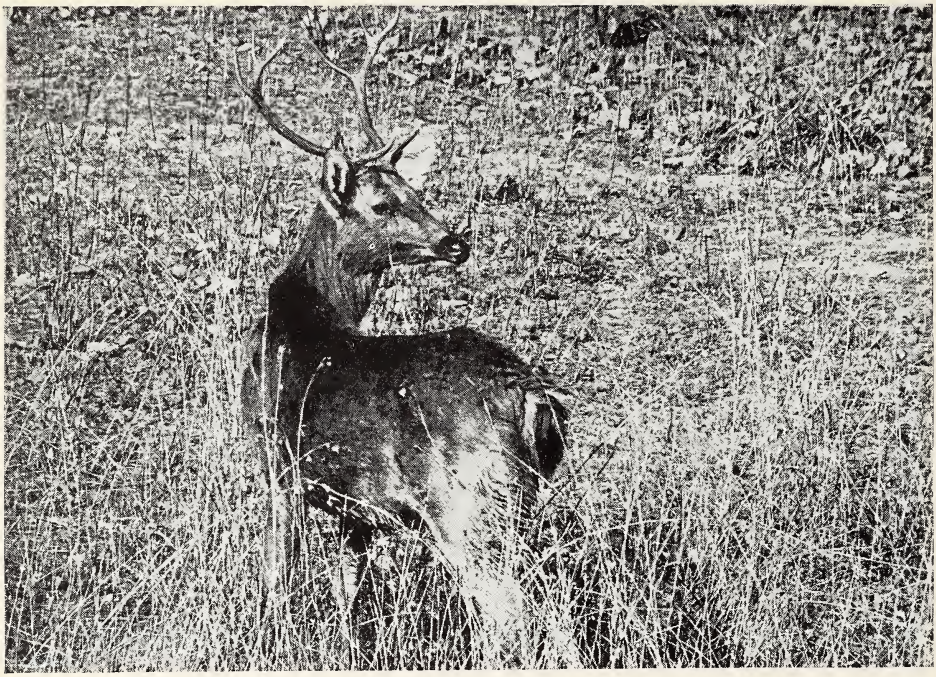
(*Photos : M. Krishnan*)

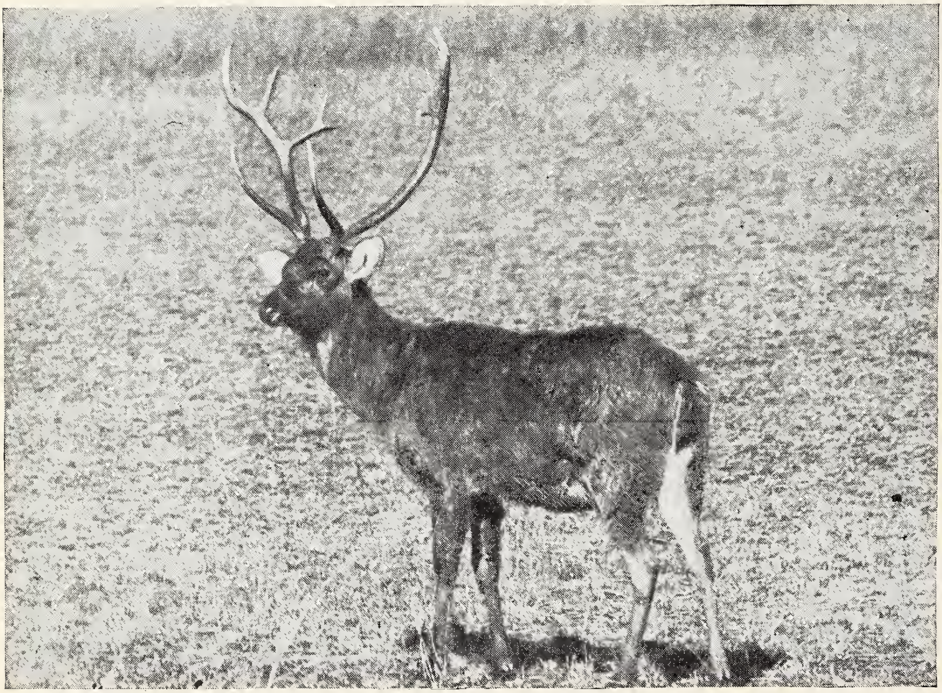




Above : M.P. 1969 : KANHA N.P. : March 8 — a.m. : The master stag of the herd in picture MP. 13 : a 12-pointer — MP. 14 ; *Below :* M.P. 1969 : KANHA N. P. : March 16 — p.m. : The 'head-up' display — MP. 19.

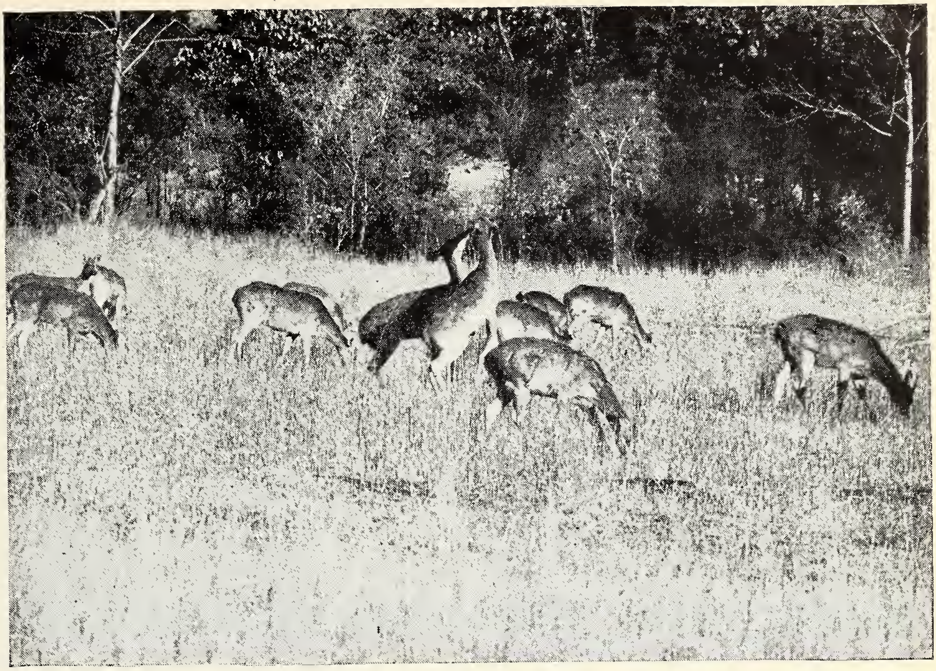
(*Photos : M. Krishnan*)

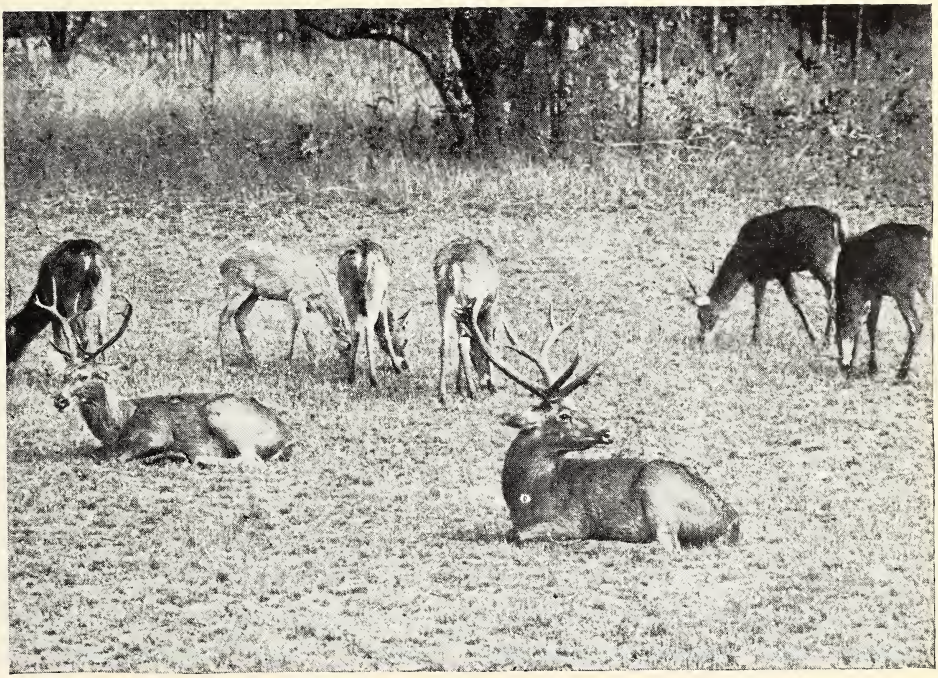




Above : M.P. 1969 : KANHA N.P. : March 17 — a.m. : Barasingha stag in his third year — MP. 20 ; *Below :* M.P. 1969 : KANHA N. P. : March 18 — a.m. : The barasingha stag with the right brow-tine broken — MP. 21.

(*Photos : M. Krishnan*)

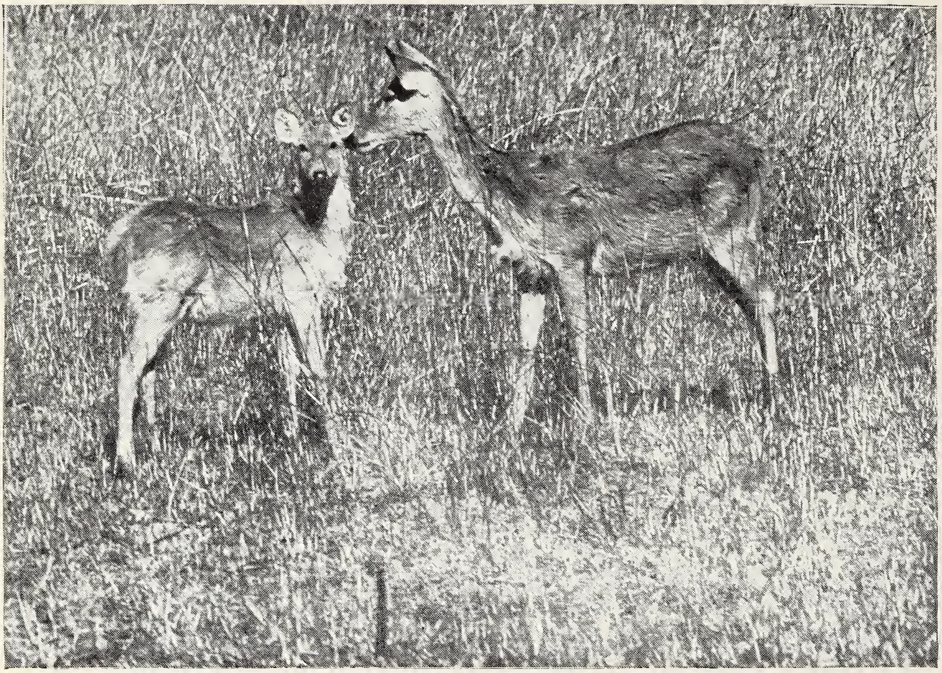


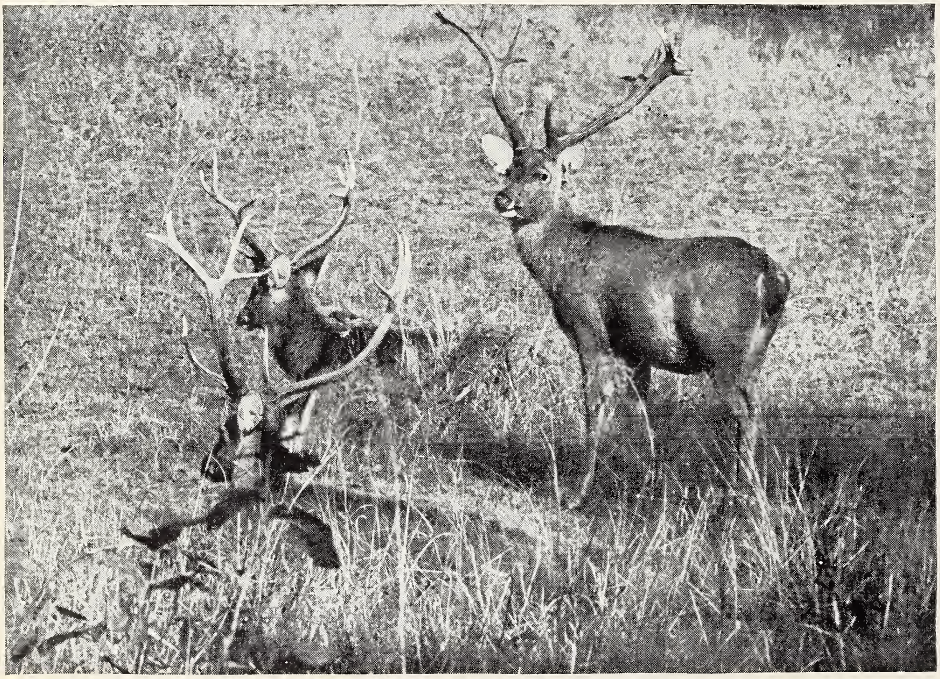


Above : M.P. 1969 : KANHA N. P. : March 19 — a.m. : 2 barasingha hinds fighting — MP. 22 ; *Below :* M.P. 1970 : KANHA N. P. : March 8 — a.m. : The multi-pointer and 10-pointer lying down, with the rest of the herd grazing — MP. 27.

(*Photos : M. Krishnan*)

Krishnan : Mammals

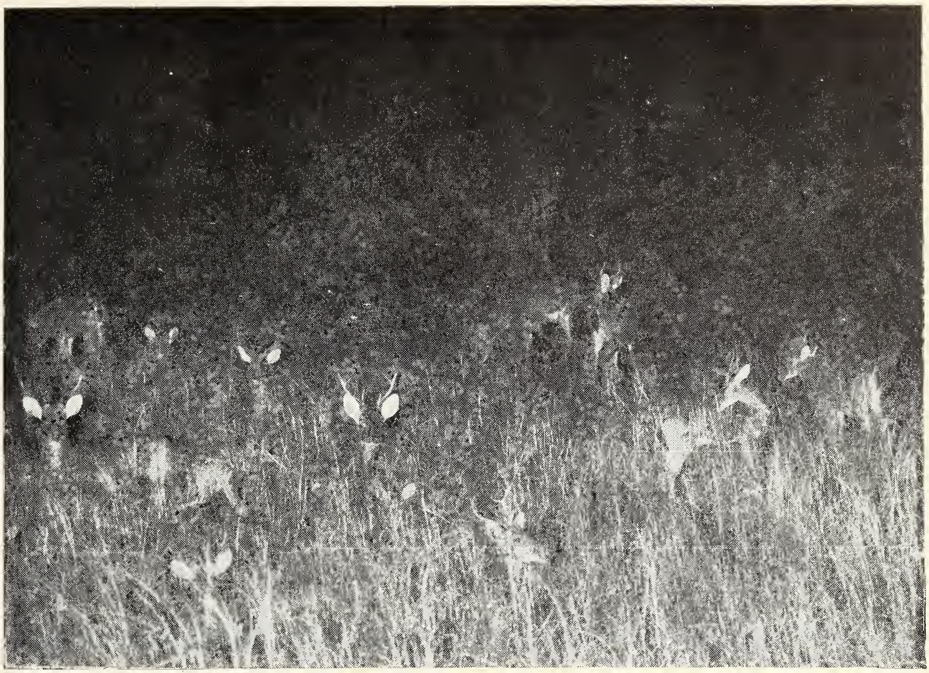


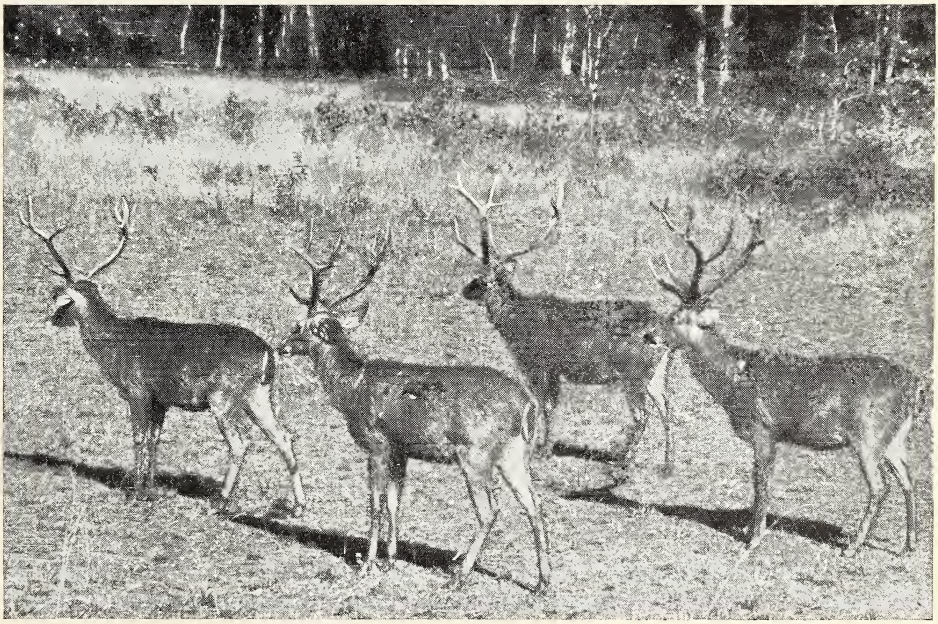


Above : m.p. 1970 : kanha n. p. : March 11 — a.m. : Barasingha hind and fawn — mp. 28 ; *Below :* m.p. 1970 : kanha n. p. : March 13 — a.m. : The big 12-pointer, the lesser 12-pointer and the multi-pointer — mp. 31.

(*Photos : M. Krishnan*)

Krishnan : Mammals

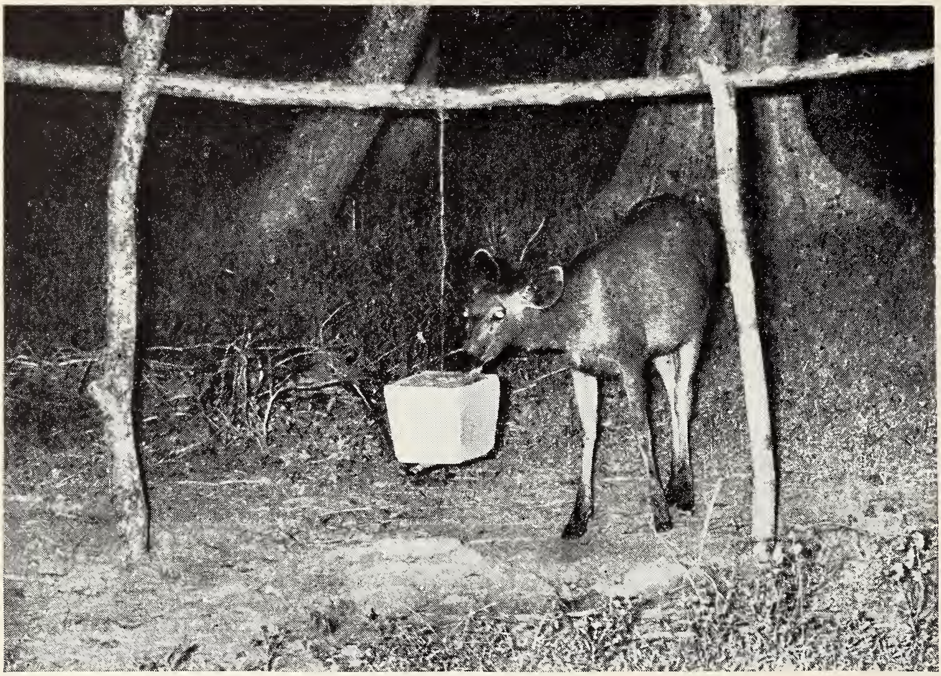


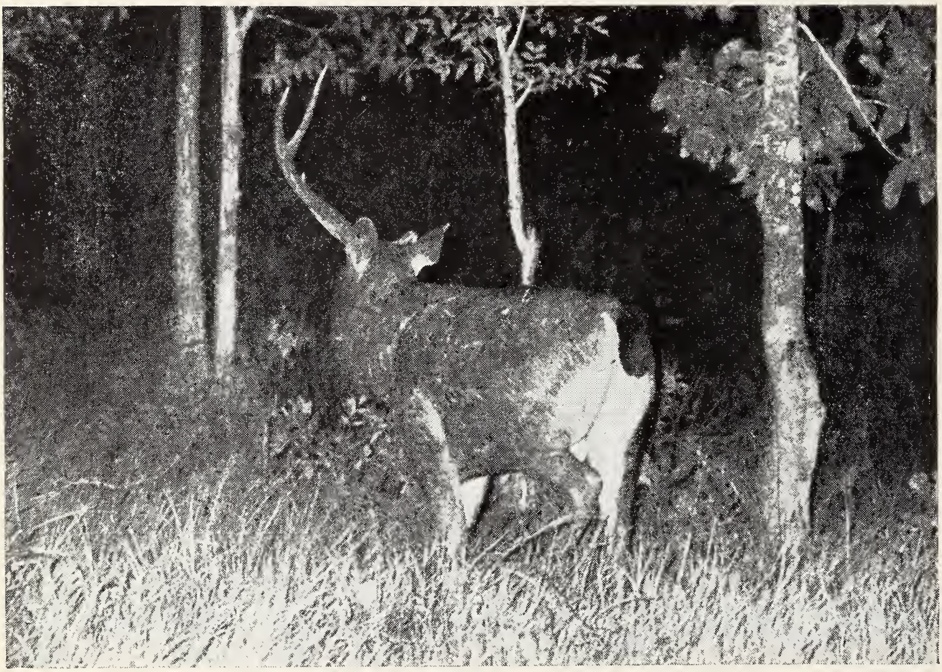


Above : M.P. 1970 : KANHA N.P. : March 19 — 10 p.m. : Barasingha lying up in tall grass — M.P. 36 ; *Below :* M.P. 1970 : KANHA N.P. : March 13 — a.m. : All the 4 big Swamp Deer stags together. Probably the finest of their kind left — MP. 32.

(*Photos : M. Krishnan*)

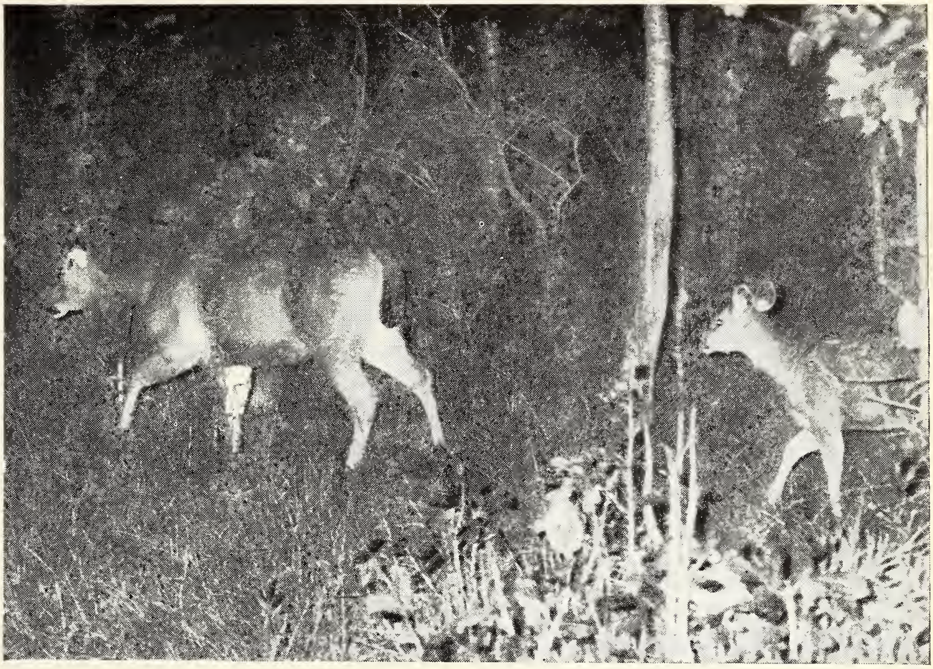
Krishnan : Mammals

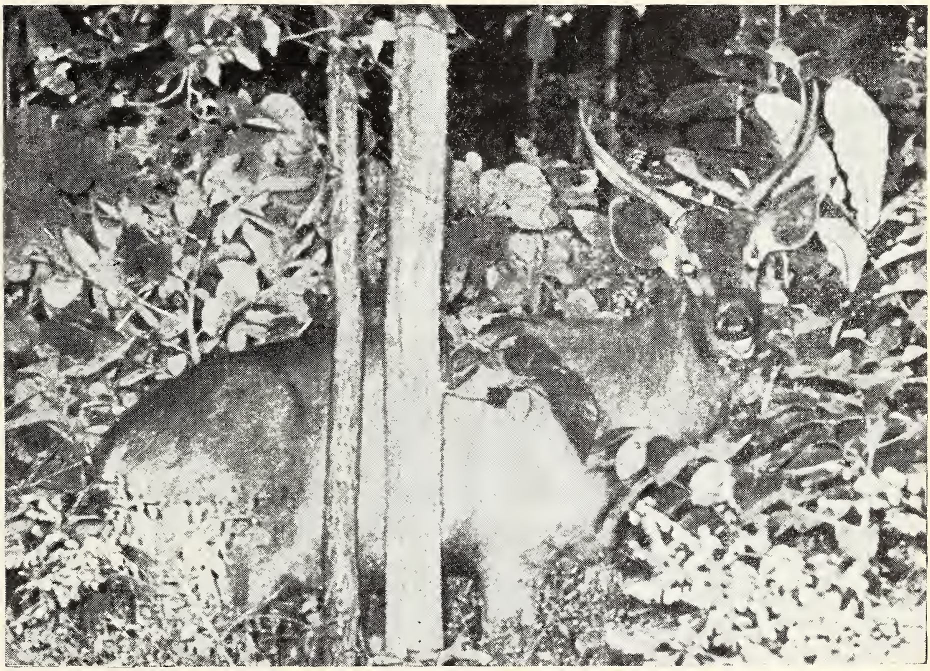




Above : MAHARASHTRA 1969 : TAROBA N.P. : November 23 — 7 p.m. : Subadult sambar licking block of salt, near Chital Road — MR. 13 ; *Below :* BIHAR 1969 : HAZARIBAGH N.P. : February 12 — 6 a.m. : Sambar stag with an antler just shed — B. 6.

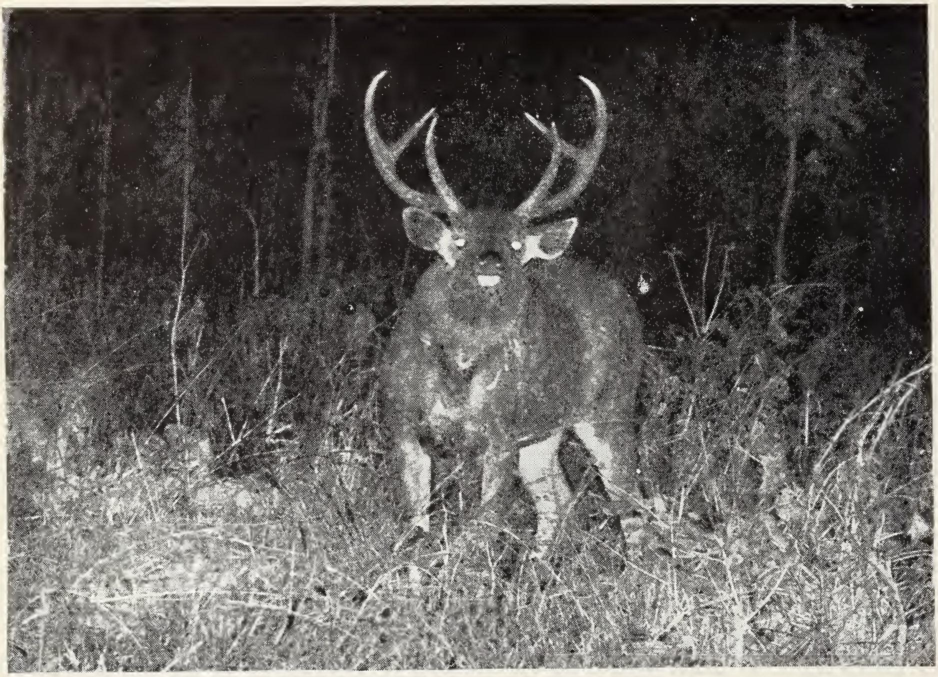
(*Photos : M. Krishnan*)

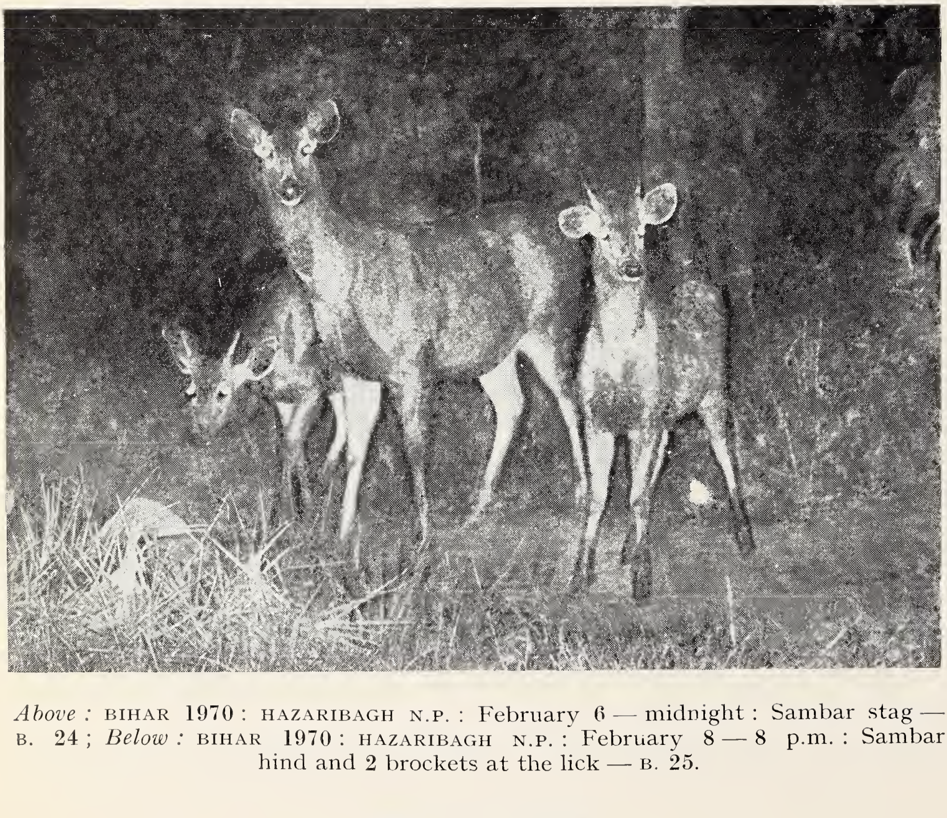




Above : BIHAR 1969 : HAZARIBAGH N.P. : February 14 — 8 p.m. : Sambar hind and fawn — B. 8 ; *Below :* BIHAR 1970 : HAZARIBAGH N.P. : February 3 — about 8 p.m. : A sambar stag (about 3 years old) chewing the cud, standing — B. 22.

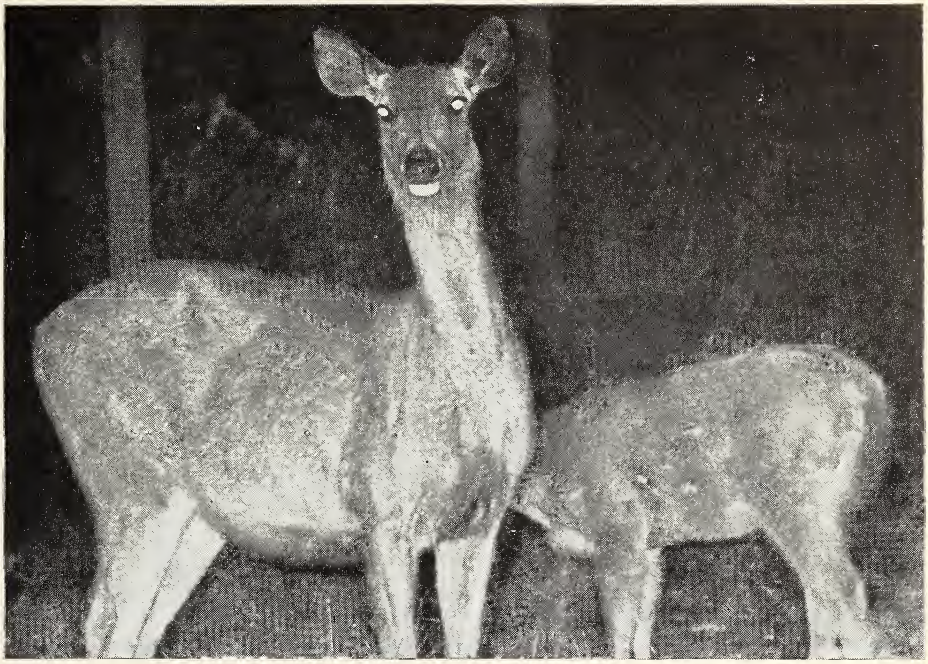
(*Photos : M. Krishnan*)

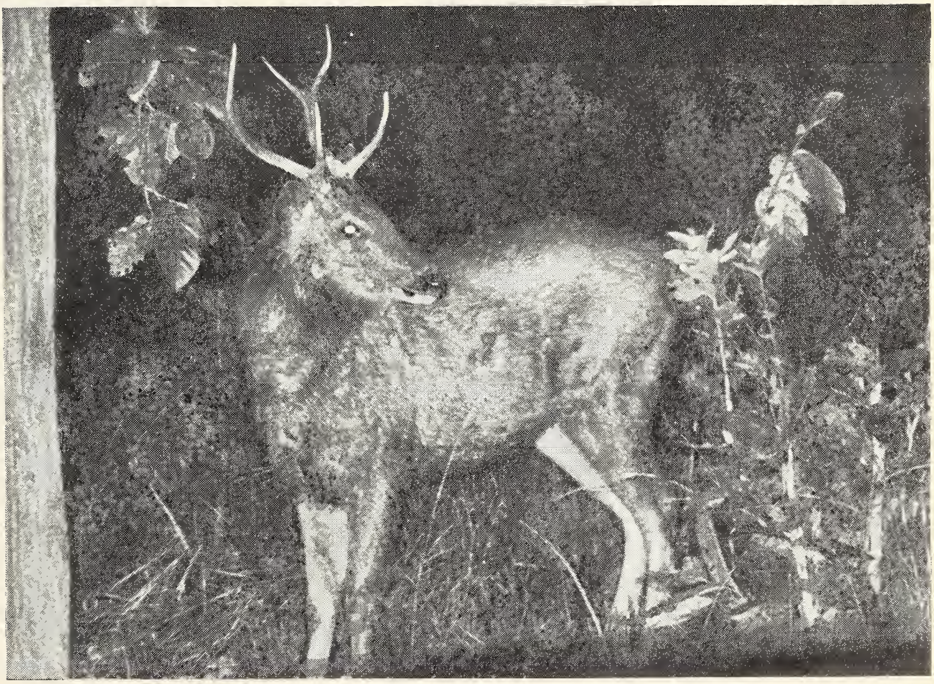




Above : BIHAR 1970 : HAZARIBAGH N.P. : February 6 — midnight : Sambar stag — B. 24 ; *Below :* BIHAR 1970 : HAZARIBAGH N.P. : February 8 — 8 p.m. : Sambar hind and 2 brockets at the lick — B. 25.

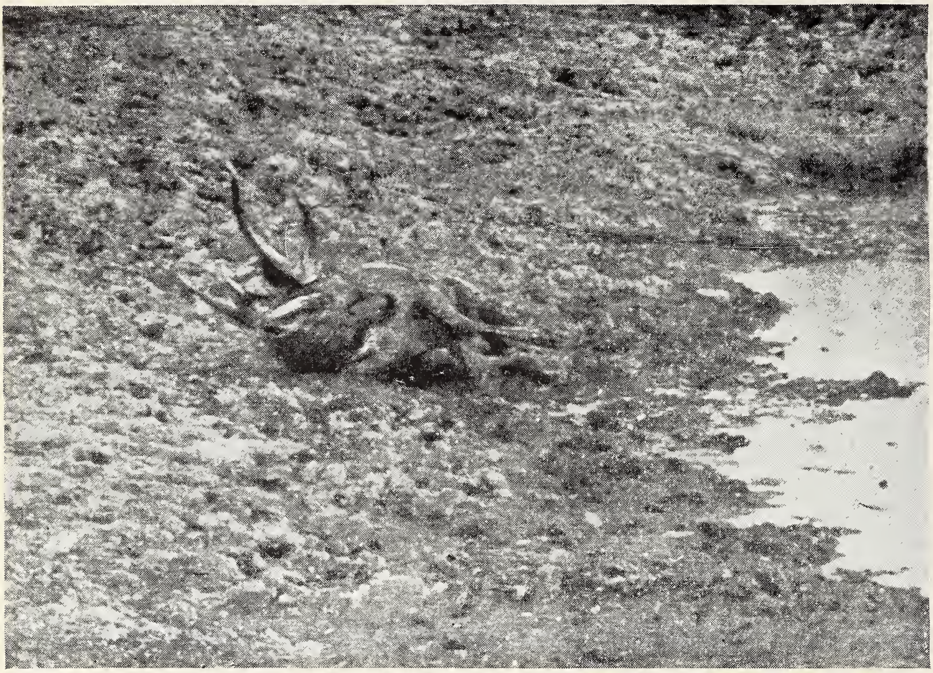
(*Photos : M. Krishnan*)

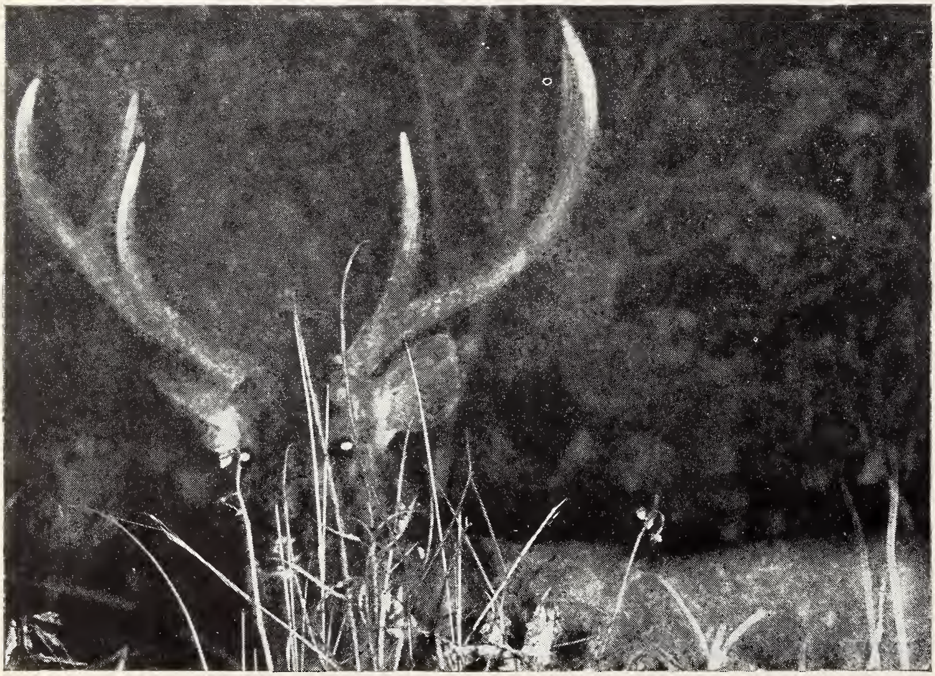




Above : BIHAR 1970 : HAZARIBAGH N.P. : February 9 — 6.30 p.m. : Sambar hind and fawn — B. 26 ; *Below :* BIHAR 1970 : HAZARIBAGH N.P. : February 9 — 7 p.m. : Sambar stag, near suspended block of salt (not shown) — B. 27.

(*Photos : M. Krishnan*)

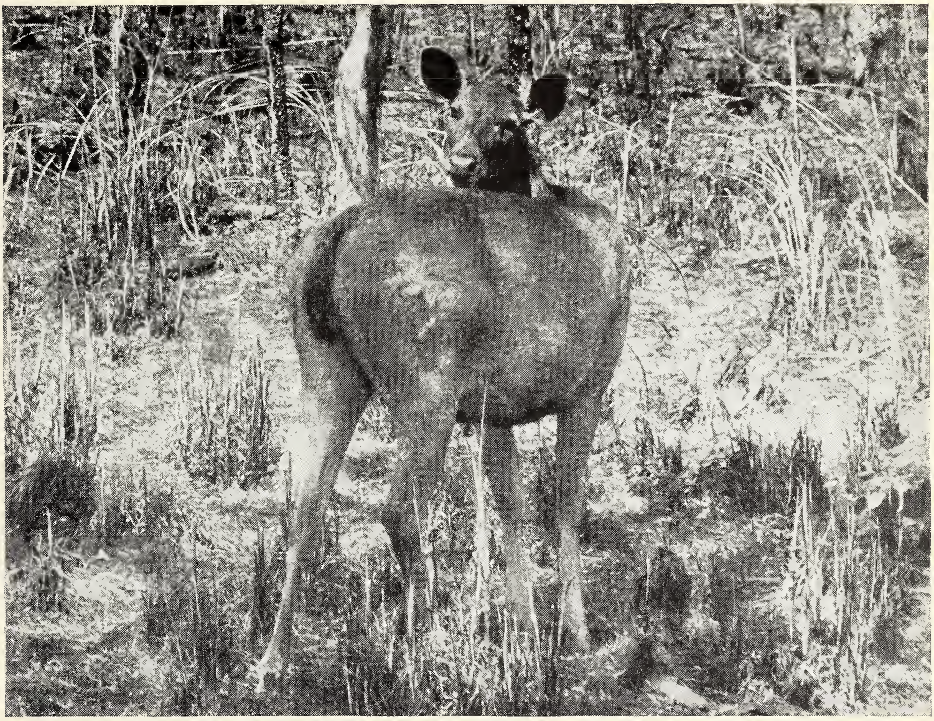


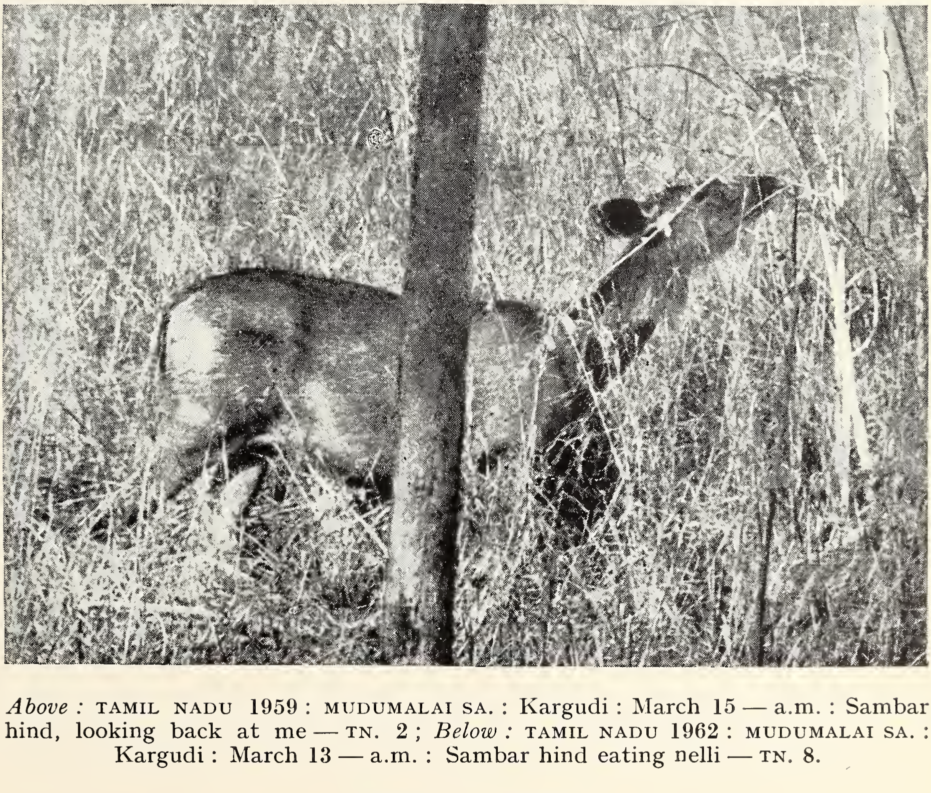


Above : BIHAR 1970 : HAZARIBAGH N.P. : February 12 — about 6.15 p.m. : Sambar stag rolling in the mire — B. 28 ; *Below :* BIHAR 1970 : HAZARIBAGH N.P. : February 12 — 10.40 p.m. : Head of an old stag : picture out of focus, but still shows the robust development of the brow-tines — B. 29.

(*Photos : M. Krishnan*)

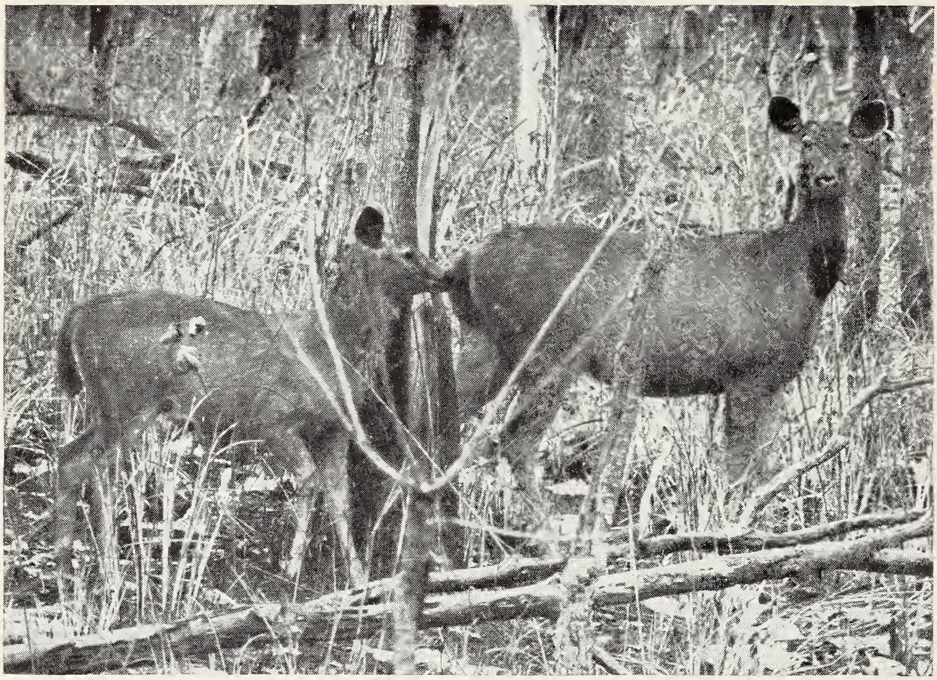
Krishnan : Mammals

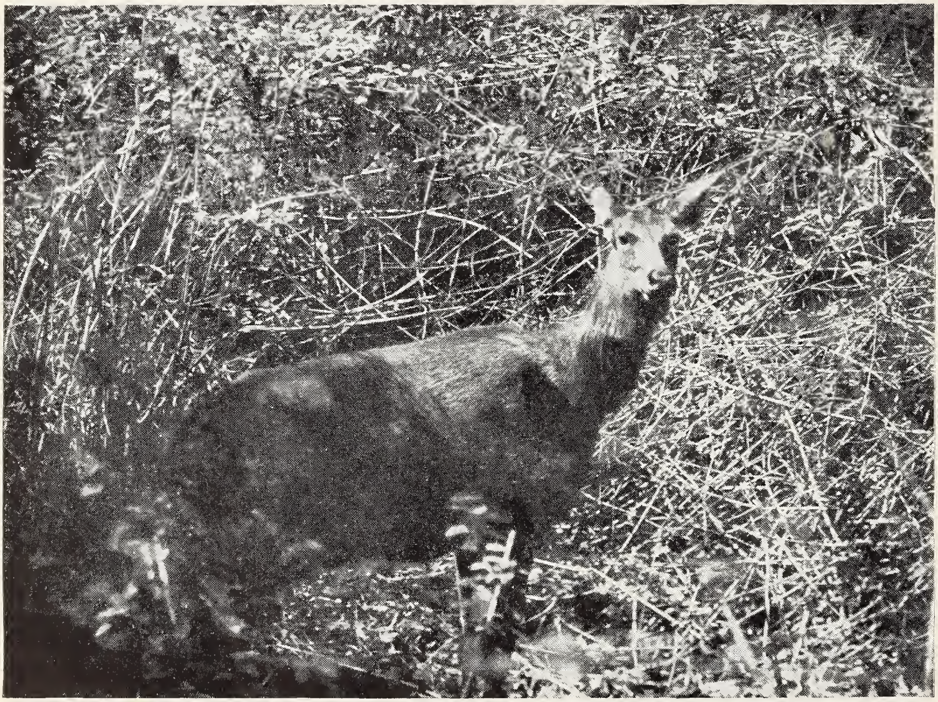




Above : TAMIL NADU 1959 : MUDUMALAI SA. : Kargudi : March 15 — a.m. : Sambar hind, looking back at me — TN. 2 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 13 — a.m. : Sambar hind eating nelli — TN. 8.

(*Photos : M. Krishnan*)





Above : TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 21 — a.m. : Sambar hind and fawn : Note sore-patch — TN. 12 ; *Below :* TAMIL NADU 1962 : MUDUMALAI SA. : Kargudi : March 24 — a.m. : Gravid sambar hind with extensive sore-patch — TN. 14.

(*Photos : M. Krishnan*)

at each other with their forelegs (MP 69 Mar. 19 : photograph MP 22).

On occasion barasingha were heard indulging in their hysterical, baying alarm, sustained over several minutes (MP 68 May 3, 69 Mar. 7 & 8) : perhaps a tiger was the cause of the excitment, the chorus of many deer baying sharply developing into a frenzied crescendo of short, high-pitched yappings : on the latter two occasions, towards the end of the baying of the barasingha, the sharp alarm calls of chital were heard in accompaniment.

Barasingha hinds indulge in a 'conversation' with one another, very much in the manner of chital hinds in a herd when in cover, but less fluently and with less variation to their mewling call. This call is a soft, long-drawn, plaintive mewling sound, not audible from a distance, and not broken up into syllables but modulated—a long 'Chchaaai' ending on a thin, querulous note. A herd of 13 barasingha split into two parties, one of 6 and one of 7 : later, the oldest hind in the party of 7 which was grazing in a nullah, came out of the nullah and crossed the open ground beyond, coming out with repeated mewling calls : 2 hinds (probably belonging to the party of 6) came up across a rise towards her, also coming out with this mewling call : the leading newcomer came up to the old hind with neck outstretched and sniffed at the head of the older hind who, thereupon, rose on her hindlegs and pawed the air right in front of the newcomer's nose with her forefeet, in what was evidently a threat. The newcomer backed a step but maintained the stretched-neck attitude which, evidently, was submissive or placatory, and then the 2 new hinds joined the party of 7 (MP 69 Mar. 16). Once I had a quite exceptional opportunity to listen to the mewling intraspecific calls of barasingha and chital at the same time and from the same spot, both the deer being equidistant from me, about 50 yards away : the barasingha's mewling call was softer, less varied and less audible (MP 70 March 21).

A mother and her young fawn (about 6 months old or younger) were observed licking each other (photograph MP 28).

Parties and herds were observed lying up in the tall grass of a nullah, some standing and some lying down : herds also lay down in an open maidan when it was cloudy and not too hot : at night the barasingha were seen lying up in the grass close together, in a herd (MP 70 Mar. 7, 8, 19 and 23: photographs MP 27 and MP 36). A large herd was seen in the water at Sravantal (MP Mar. 8).

A sharp lookout was kept for stag parties, but though several such parties were seen, none was large : no stag parties of over 10 animals or so were seen, and even in Assam where I saw larger stag parties (of *Cervus duvauceli duvauceli*, in the Kaziranga Sa.) nothing like the large stag parties of chital seen in the Masinagudi area of the Mudumalai Sa. was noticed. The largest congregations were mixed herds. consisting mainly of adult hinds, with a few fawns, a few yearlings, and a very few adult stags or only a few brockets : herds of about 50 (1 adult and 2 young stags), 33 (no adult male), 47 (one dark adult stag, 2 younger stags, 3 brockets, 9 animals well under one year, rest hinds), and 32 (mainly adult hinds, no adult stag) were seen (MP 68 May 1, 68 May 5, 69 Mar. 8, 70 Mar. 17: photographs MP 2, MP 13).

The most striking characteristic of the barasingha seen in Kanha was their lassitude, as compared to other (marshland) barasingha seen in U.P. and Assam. No doubt at Kanha they are used to the sight of men, and because of this, and also because of the general tendency of animals to permit a close approach when men are in a motor vehicle or on elephant back (and not on foot), they permit one to get quite close, but making allowance for all this, I was still struck by their lassitude, and did not think it merely familiarity with men—in this connection, it is worth remembering that the barasingha at Kanha do not stay in the meadow round the year, and that they come in from all round and that Schaller thinks poaching is partly responsible for the decline in their numbers—it is my experience that animals hunted or harassed are never unduly trustful of men. Schaller thought to high mortality among infants he noticed was probably due to brucellosis, and it could well be the lack of wariness and vivacity I noticed was also caused by the debilitating effects of the infection.

The population evaluations of barasingha at Kanha park are based on the deer visiting the meadow during summer. The deer seem to arrive here from many places around, and although the population in the meadow substantially represents the total population in and around the park, a few may go elsewhere (to places not known at present); the arrival of the multipointer at Kanha in March 1970, when he was not there in 68 and 69 suggests this, *if* the antlers he carried in 1970 were representative of those he carried in 1968 and 69. Anyway, the survival of the hardground subspecies of barasingha is dependent almost entirely on the deer in Kanha : the isolated small herds, parties or individuals known elsewhere, as at Bastar, have small chance of survival.

Schaller thought the Kanha population totalled around 50, and that the official figures (about 100) were rather high. That may have been so for the 2 years he studied the deer here. I watched the census being taken and thought the official *modus operandi* somewhat haphazard : for example, it completely missed a herd of 19 I was watching in a nullah that day (MP 70 Mar. 7). Even if, as I think, there are about 100 animals left in Kanha today, there is little room for complacency in this number. There were several hundreds here only a few decades ago and thousands earlier, and these undoubtedly represent the last stable population of hardground barasingha anywhere. Various causes for the decline of the deer at Kanha have already been mentioned. I think (I realise that others differ from me over this) that the artificial attraction of tigers to the Kanha meadow has definitely resulted both in the decline of the barasingha and in the decline of the tiger in this park. Whether or not this is true, everyone agrees that unless immediate steps are taken to save this particular subspecies of the barasingha, it will inevitably become extinct. A plan based on capture and release into a large stockade of a few animals, to be protected and studied, is being carried out. In 1968 I suggested a scheme for introducing fresh blood, from the marshland subspecies of U.P. : my scheme, based on genetical factors and the experience of breeders of pedigreed dogs and other domestic animals (whose breeds differ much more in physical characteristics than the 2 subspecies of the barasingha do) is probably difficult of operation. Anyway it is not being pursued. With the position of the hardground barasingha so precarious, it was heartening to note a distinct improvement in the fawn and yearling ratio to adults in 1970. Whether or not this improvement will be maintained is something that only time can tell.

I do not know on what taxonomical grounds the genus *Cervus* is distinguished from the genus *Axis*, but think that barasingha in Kanha show a much greater affinity to chital than to sambar : till recently sambar too, were not included in the genus *Cervus*, but at one time it was suspected that barasingha and sambar interbred occasionally. I think that if barasingha interbreed with other deer, it is more likely to be with chital, not in the wild, but in captivity.

THE SAMBAR

Cervus unicolor Kerr

(Summary of field notes: Observation records : 200 +.

Locations: Kerala—Periyar Sa.; Tamil Nadu—Mudumalai Sa.; Mysore—Bandipur Sa.; Andhra Pradesh—Kawal Sa.; Orissa—Raigoda Sa., Usha Kothi Sa.; Bihar—Hazaribagh N.P., Palamau N.P., Tholkobad, Karkatnagar; Madhya Pradesh—Churna, Shivpuri N.P., Kanha N. P.: Maharashtra—Taroba N.P.

Photographs: K 8: TN 2, TN 8, TN 12, TN 14, TN 26, TN 35, TN 44, TN 45 and TN 59: B 6, B 7, B 8, B 22, B 24, B 25, B 26, B 27, B 28 and B 29: MP 34: MR 10 and MR 13).

The sambar was one of the very few animals seen in all the 8 States in which the survey was conducted, and it was also observed outside the survey areas. The opportunity to study it in so many diverse locations was rewarding. Although a typical forest deer, also found in hilly tracts where there are extensive belts of tall grass, it does not favour dense tree growth and is essentially a creature of the more open deciduous forests, and is found even in dry forests with little tree shade in summer. It is much more diurnal in its habits than is generally realised though it does forage by night as well, and where it is not disturbed by men is commonly abroad by day. Its tolerance of the sun and heat are remarkable. Since this account is based largely on field observations (supplemented by photographs), in order to avoid needless length much of the information available on sambar in faunal literature (such as an account of its distribution) is not repeated here, but necessary references are specifically cited.

Size : *Morphological characters*

Size varies considerably with locality and strain, but the sambar is definitely the largest of all Asiatic deer and seems to attain its best development in India. Stags are taller than hinds and usually much heavier : a very big stag may stand some 56 inches high and weigh 700 lb, a small adult stag only 48 inches in height, and 450 lb in weight, or even less. There is no direct correlation in stags between body size and antler development : some very big stags may carry comparatively poor antlers, and some medium-sized ones exceptionally well-developed antlers. There is a distinct trend towards small body size in the drier and more open forests, especially those in the plains, and generally speaking sambar are smaller in the southern parts of the peninsula than in the northern parts. The most magnificent body development seems to be attained in the north-western areas of Orissa, on the Bihar border, and in Bihar near that border and in certain other areas such as Hazaribagh, and some stags of the most impressive size were seen in Badrama, Singhbhum, and Hazaribagh (O 69 Jan. 27; B 69 Feb. 4 and 5/6, 68 Apr. 17, 68 Feb. 12, 70 Feb. 2 and 13) ; a peculiarity of these big stags is the robust development of the brow tine—though the antlers may not be notably long, they are heavy and well-beaded in the beam and the brow tines are notably long and heavy (O 70 Jan. 25 ; B 68 Apr. 17 and 70 Feb. 12 : photographs B 24 and B 29). A mounted head at the rest-house at the Usha Kothi Sanctuary (Badrama) was only 33 inches long measured along the curve but very thick and with the brow tines heavy and fully 16 inches long : another mounted head at the Forest Training College in Champua, near the Bihar border, was 40 inches around the curve from base to tip of the outer tine of the beam and the brow tines were 18 inches long : a comparison of the length of these with those of antlers from other parts of India shows that in parts in Madhya Pradesh an equally notable development of the brow tines is seen in exceptionally thick antlers (Dunbar Brander) but not in other areas, and that in many antlers notable for their length (Forsyth's record head, for example) the brow tines are comparatively much shorter ; in other parts of the peninsula, the brow tines do not seem to be developed to this extent. Note that both photographs B 24 and B 29 show antlers notable only for their brow tines, and otherwise of modest length.

It is generally said that old stags are very dark, almost black. Where the winter and summer coats are notably different (as they are not in the southern areas of the peninsula) the winter coat is usually much darker, but not always so. I have seen many old stags, even in winter coat, whose pelage was not specially dark, and some whose pelage was somewhat light, being tinged with pale raw umber. The large, obovate ears have much less hair on their insides than in barasingha or chital, and are not conspicuously white on the insides as the ears of those two deer are. There is no white on a sambar, but on the rump and the insides of the legs, especially where they join the body, and on the chin, the hair is usually much paler, a light, warm sienna or even pale ochre. The dorsal aspect of the tail is always black or a very dark blackish brown. In spite of their strong build, quite burly in adult stags, sambar are the most graceful of all deer in their movements, and run swiftly over uneven ground with surefooted ease.

Perhaps the most remarkable feature of the sambar is the wide prevalence of the sore patch in adults, a raw, red patch devoid of hair, at the base of the throat, not found in any other deer : this has been termed ' sore spot ' by most writers, but is termed ' sore patch ' here as the sore is not a spot but much more a patch covering the base of the throat and extending up the neck on either side when extensive. The patch is always ventral and median and usually situated at the base of the throat, though it may start as a thin vertical line of rawness a little higher up—as Dunbar Brander points out, there is a prominent whorl of hair at the throat (clearly shown in photographs B 7, B 8 and B 25—though in the sambar shown there is no sore patch) where the sore patch is situated, the whorl disappearing with the formation and spread of the ' sore '. The patch varies in size from about 2 to 10 inches in diameter, and is usually shield-shaped : in all but incipient or undeveloped sore patches, there is a white-mouthed tubercle placed below the centre, and the skin around is bare of hair and extravasated, a flesh-tint to red in colour : sometimes there is blood on the sore patch, and it is usually coated by a thin, serous exudation, which shows up when the light is strong on the patch—the sore patch is not a dry, angry-looking area of skin (TN 66 Apr. 9 : photograph TN 44). I have never seen the patch on a fawn and not often on a yearling. The sore patch is not a universal feature of sambar everywhere in the peninsula—it does not seem to occur among sambar in the Hazaribagh National Park, a faunal area specially noted for its sambar : I did not see a single sambar in the Taroba N.P. which exhibited a sore patch, in November 1968 and November 1969. In the Kanha N.P., the patch does not seem to be as extensive as it is in other parts of the peninsula, for example the Mudumalai and Bandipur sanctuaries. In the Mudumalai sanctuary, most of the adults (but not all) seen in March, April, September and October carried the sore patch.

From time to time theories have been advanced to explain the sore patch, some of them diverting. Schaller mentions most of these theories, but not what may be termed the Abrasion Theory, i.e., the theory that the sore patch is the result of the skin at the base of the throat getting abraded in the course of the sambar's passage through hard or spiky undershrub—this theory ignores the fact that sambar living in areas where the undershrub is not hard also show the sore patch and that the 'sore' is invariably located at the same spot, and is on the ventral median line of the throat and perfectly symmetrical. Schaller himself thinks that the sore patch has a sexual significance, the exudation from it being rubbed off on the vegetation to provide scent markings in the course of the sambar's movements through cover : in fact, he argues a different breeding season for sambar in the Kaziranga Sanctuary and the Kanha N.P. on the basis of the different months in which the animals with sore patches are seen in both sanctuaries, and says that in Kanha the patch is seen invariably on adults in November-December, and only from mid-November to mid-December. I saw the vertical commencement of the sore patch on the necks of 2 adult hinds at Sravantal lick (in Kanha) in March (MP 70 Mar. 17 : photograph MP 34 : the flash picture clearly shows the medium vertical incipient sore patches on both hinds). Further, I do not think the sore patch has any sexual significance. I have seen it on hinds with very young fawns at their heels, when they were still in the phase of lactation and could not have been in breeding condition (TN 62 Mar. 21 : photograph TN 12, TN 62 Mar. 24, Apr. 7, 66 Apr. 1 and 2), and also on a heavily gravid hind (TN 62 Mar. 24: photograph TN 14 shows the extensive sore patch), and also on stags in velvet (TN 66 Apr. 4)—quite adequate evidence of the sore patch having no sexual significance.

I agree with those that suggest a glandular basis for the patch : its location and the white-lipped mouth of the patch does suggest some glandular activity. Clearly it is nothing pathological, but normal, considering the commonness of its occurrence. Inquiry made at Hazaribagh N.P. elicited the information that at no time were sambar with flagrant sore patches seen—even outside the months of February and April when I worked in the sanctuary. Sore patches were seen in Singhbhum early in February (B 69 Feb. 5/6) and in Kanha N.P. in March.

The truth seems to be that although the sore patch is such a flagrant and remarkable feature, and uniquely confined to sambar among deer (or, for that matter, among all mammals) no work to determine its histogenesis or even periodicity has been done : seeing that sambar in confinement (as in zoos) also develop the sore patch, scrapings from the sore and biopsy should be helpful in determining its true nature.

Habits : Behaviour

Sambar vary widely in their habits and responses, being such versatile animals. However, Prater's statement that they 'retire into heavy cover at daybreak and do not usually come out till dusk' is based entirely on the evidence of hunters to avoid whom the animals have turned nocturnal and crepuscular, and is not true : compelling evidence on this point is offered by my field notes and photographs, but to avoid needless length I am not referring to the hundred and odd occasions on which I have watched sambar by day, but am merely citing the photographs showing sambar going about their normal activities by day, in the morning, in the forenoon and in the afternoon (photographs TN 2, TN 8, TN 12, TN 26, TN 35, TN 45, and TN 59—there are dozens of other photographs, not reproduced here, showing sambar feeding or relaxing in the open, by broad daylight).

Sambar are much less gregarious than chital or barasingha, and are often seen alone, especially the stags, or in family groups of a fawn and its mother, sometimes accompanied by a yearling, evidently the adult hind's young from the previous year (TN 59 Mar. 9, Mar. 15, 62 Mar. 13, Mar. 21, 64 Mar. 19) : 2 or 3 adult stags may also be seen together (TN 63 Mar. 26, 64 Mar. 19, 66 Sep. 18) : or the deer may be seen in parties of from 4 to 8, which may or may not include an adult stag and one or two young. The largest congregation I have seen was a herd of 15 (TN 64 Mar. 23), but H. Subba Rao, the knowledgeable Range Officer of the Bandipur Sanctuary told me in October 1968 that he had be seen sambar in herds of over 20 on a hill on the outskirts of the sanctuary.

A feature of the deer is that when a small party is disturbed but not alarmed, and is followed cautiously at a distance, it very often leads to another small group, and that the two join and proceed to yet another group or individual, gaining strength in this manner till a dozen or so are together, when they usually bolt. (TN 59 Mar. 12, 66 Mar. 31, 66 Apr. 3). Hinds with young fawns cache their young in tall grass, but when not alarmed and moving away go up to them and nuzzle them to get them to follow (TN 66 Apr. 7).

Sight is acute, and the ability to see small movements and even to make out stationary objects is good. I have never been able to get close to sambar by stalking them prone over open ground when the wind was in my favour, though chital can be approached in this manner. The sense of hearing is also acute, the animal being able to distinguish between normal and suspicious sounds (TN 63 Apr. 3 : photograph TN 26). Smell, of course, is the paramount sense. Sambar do not wait for visual confirmation when alarmed by scent, but when not unduly alarmed may seek it (TN 63 Mar. 17, 66 Apr. 14). During heavy rain they are evidently unable to scent and hear possible danger, and are, naturally not able to see things clearly either : at such times they stand immobile in the open instead of seeking cover (TN 62 Mar. 21, 66 Sep. 26).

The alarm call, an explosive ' dhank! ', is sounded when the animals are sure of their ground and getaway, a forefoot being also stamped repeatedly (TN 66 Sep. 26: B 70 Feb. 17 and 24).

Leadership in a party is not necessarily determined by the criterion of which animal is in the lead. More often than not, as in most deer and even in gaur, the dominant member of the party stays more or less to the middle and directs a younger, subordinate animal to take the desired line. A bite-threat is commonly employed for this purpose, the dominant sambar moving forward towards the subordinate member of the party with the mouth held menacingly open—the general attitude of the threatening animal is also menacing (TN 64 Mar. 19, 66 Apr. 10). Once a chital hind was seen in association with a sambar hind and fawn which had, on a previous occasion, permitted a close approach on elephant back, but because the chital was apprehensive and bolted at the least move on our part (chital are apprehensive of men on elephant back and even of elephants, much more so than most other animals) the sambar also bolted with their ' guide ' (TN 59 Mar. 17).

Sambar lie up in company, choosing open ground for this. The amount of heat they can stand is astonishing. They do not seem much bothered by forest fires, and a hind (with a fawn) was seen standing by freshly charred ground watching unconcernedly a forest fire close by (TN 59 Mar. 15 : photograph TN 2). A party of 7 (3 adult hinds, 3 near-adult hinds and a brocket) lay down in a close group on open, charred ground directly in the afternoon sun, whose heat was oppressive (TN 64 Mar. 26). During forest fires in summer, sometimes it happens that a dead, fallen tree gets set alight, and thereafter for weeks the fire may keep smouldering in the heart of the bole, burning it out to the periphery, leaving a long, conspicuous trail of white ash (marking the burning of the tree) on the forest floor till the heavy rains wash away the ash. I had long known that sambar liked to lie down close to such smouldering fallen trees, but was unable to secure proof till 1964. In 1964, a party of sambar toasting itself close to a long-dead, smouldering *Terminalia tomentosa* was watched over several days and the field notes contain a full record of the observations (TN 64 Apr. 2, 3, 5, 7 : photograph TN 35). The radiated heat by that smouldering tree was oppressive, and the sambar were basking by the fire when the sun itself was scorchingly hot ! Another sambar was seen basking besides a smouldering log two summers later, in a locality far from the scene of the first record (TN 66 Apr. 7).

Dunbar Brander has pointed out that when winter mornings are frosty, sambar lie up in the water, which is warmer—they do so even in the Nilgiris. Apparently they are more sensitive to the cold than to heat.

Sambar are versatile in their feeding, browsing leaves and twigs, eating tree bark, grazing on a variety of herbs (mainly tall grasses) and consuming quantities of forest fruits. After a forest fire, they are probably the first animals to seek out the fresh sprouts of grass—other animals wait till the new grass has sprouted a little higher. (TN 59 Mar. 9). Leaf buds and tender twigs are also choosily eaten, and the foliage and twigs of *Ardisia solanacea* eaten in bulk (TN 66 Apr. 19). The foliage of *Emblica* spp. (much eaten by most herbivores), the foliage and twigs of *Grewia aspera*, *G. hirsuta*. *Hibiscus lampas* (flower also eaten), *Helicteres isora*, the fruits of *Randia dumetorum* and *R. uliginosa*, ber, *Emblica* spp., *Diospyros* spp., and figs are all eaten (TN 62 Mar. 13 : photograph TN 8, 62 Mar. 16, 64 Mar. 19). In the Taroba N.P. sambar were observed feeding on some aquatic sedge or grass and in Bandipur Sa. on *Enteromorpha intestinalis* in a forest pool (MR 68 Nov. 19, 26 : MY 68 Oct. 11).

It is said by all authorities that sambar have a definite breeding season, though this may vary with climatic factors and differ in different regions. The shedding of the antlers seasonally and the birth of young, also in a specific season, are cited as evidence of the existence of a definite breeding season, though these, too, may vary with regional variations and lie in different months in different locations. Regarding the casting off and regeneration of antlers, the evidence available is confusing. Prater says, ' In central and southern India the majority of stags cast their antlers between the end of March and mid-April ' and that the new antlers are clear of velvet by November. Taking the Mudumalai Sa., as being representative of the region Prater speaks of, some stags which had just shed their antlers were seen in March-April (TN 63 Mar. 19, Apr. 8) ; many were in hard horn during these 2 months (TN 62 Apr. 6, 63 Mar. 21, Apr. 3 : photograph TN 26): some stags were also seen clearing the velvet from fully formed antlers (TN 63 Mar. 12, 64 Apr. 11, 66 Apr. 7). Further, stags in velvet were seen in September here (TN 63 Sep. 12, 66 Sep. 18). Evidently there is no defined season for the shedding of antlers in this area.

The evidence of birth is much more cogent. Prater, evidently following Dunbar Brander, says ' the young are born at the commencement of the rains, in May or early June '. In the south of the peninsula they appear to be born earlier. A point on which my field notes are consistent in that all very young fawns seen in the Mudumalai Sa. were seen in March, and that the only fawns seen in September-October were juveniles at least 6 months old.

Wallowing, associated in deer with the breeding season, seems to be indulged in at all times in sambar and to have no special sexual connotation. A stag rubbing the velvet off his antlers was observed soon after he had wallowed in a patch of swampy ground (TN 63 Mar. 12), and another with his coat spiky from recent wallowing (TN 66 Apr. 17). A big stag was observed wallowing at the Hazaribagh N.P., at a time when there was no breeding activity (B 70 Feb. 12 : photograph B 28).

THE CHITAL

Axis axis (Erxleben)

(Summary of field notes : Observation records: 300 +.

Locations : Tamil Nadu—Guindy Park, Mudumalai Sa.; Pt. Calimere Sa.; Mysore—Bandipur Sa.; Andhra Pradesh—Eturnagaram Sa.; Orissa—Majhipara, Usha Kothi Sa.; Bihar—Palamau N.P.; Madhya Pradesh—Kanha N.P., Churna, Shivpuri N.P.; Maharashtra—Taroba N.P.

Photographs : TN 21, TN 25, TN 41, TN 42, TN 54 and TN 55: MY 1, MY 2, MY 8, MY 12, MY 13, MY 14, MY 15, MY 18, MY 20, MY 21, MY 24, MY 25, MY 26, MY 27, MY 28, MY 29, MY 30, MY 31, MY 32, MY 33 and MY 34 : B 13, B 17, B 18, B 19, B. 31, B 33, B 35 and B 36 : MP 6, MP 16, MP 17, MP 18, MP 25, MP 29, MP 30 and MP 34: MR 7 and MR 8).

It was not by chance that the animal seen oftenest during the survey period was the chital of which more than 300 distinct observation records are noted in the field notes, documented by no less than 44 photographs. Since, naturally, all animals seen in a herd were listed as one sighting, the total number of chital seen must be several thousands, although none was seen in Kerala, and only a few in Andhra Pradesh and Orissa. The chital is undoubtedly the commonest wild animal of peninsular India, and I think it is the most adaptable and the fastest breeding of all Indian deer. Chital have been hunted as widely and assiduously as any other wild animal, by every class of hunter, but still thrive where all others have dwindled.

Quick breeding is not the only, or even the main, reason for the chital's survival where so many other species have declined so quickly. Adaptability, the ability to colonise new areas as it is deprived of established territory, and the ability to exist in a reduced physical condition are all of obvious survival value to any animal faced with many kinds of adverse influences, and the chital has all these qualities. Perhaps it is the best example of vitality being very much a matter of bionomic flexibility, but before detailing this important aspect of its life, a limitation imposed on breeding in some fast-breeding herbivores should be pointed out.

Among chital (as in most herbivores) copulation is over in a few seconds, and there is marked sexual promiscuity, but for these reasons it cannot be presumed that swift matings lead to fast breeding. In some animals (notably the primates) the sexual urge, seasonally or periodically compulsive, finds comparatively uncomplicated and casual expression in easy access, promiscuity, or coercive male dominance. Among chital (as in most deer) the ritual of courtship, which may be longdrawn, precedes copulation (TN 64 Oct. 2, 6 : photograph TN 42). It is not as if a chital stag walks into a herd where there is a receptive hind, mates with her, and passes on—the courtship, in full or at least in abbreviated form, has to be gone through. For this reason, matings may on occasion be frustrated by other factors, such as disturbance, but after all it is the oestral cycle of the female and the period of gestation that mainly determine the rate of breeding and not the overt male-female pattern of sexual behaviour, and even if it is presumed that extraneous factors may frustrate mating in as high a proportion as 10% of the total possible matings, it makes little difference to the rate of breeding, for 90% of all fertile females that come into season will be impregnated, conceive and give birth to young after the period of gestation of the species. It should be noted that population levels are not dependent only on birth rate : infant and juvenile mortality are important factors in limiting populations, but of course a high birth rate will compensate in a measure for such mortality.

The fact that chital are highly gregarious has itself considerable survival value. It is usually found in herds and though the composition of the herd may be unstable and readily alterable, the fact remains that the animal goes about in herds. Animals in close herds are better warned and better protected against predators and accidental damage, and though such gregariousness does have its own attendant risks (as when an individual contracts an infectious disease), it also serves to stimulate free ranging and thereby leads to more efficient feeding.

Much more than this, the chital's ability to feed on what offers, and its adaptability with regard to cover, terrain, and even sources of water (which it must have) have great survival value. It is always the animals with rigid or specialist feeding habits that are most affected by hostile influences. The chital is truly versatile. Introduced into the Andamans where the floristic and territorial settings are so different from what it is used to, the chital has overrun the islands and flourishes, to the acute embarrassment of the Forest Department. In the Sunderbans the chital swims across channels, feeds on plants very different from those of its usual haunts, and even eats crabs.

The chital appears to be originally and mainly an animal of the more open, well-watered forests, where deciduous tree cover alternates with maidans and belts of open scrub : though very different in their floristic and other characteristics, the Corbett and Kanha N.Ps. and the Mudumalai and Bandipur Sas. have these main features, and it is here that chital attain their best development. However, introduced or straying into dense forests, they change their habits readily, go about in small parties rather than in herds, and usually decrease in size—no information is available on the size of chital in the Andamans, but if other factors do not influence it, on the basis of what has been said it should be a smaller size than that attained by chital in the parks and sanctuaries mentioned. Introduced into dry, thorny littoral scrub, as in Guindy Park and Point Calimere, chital degenerate in size and forage in parties rather than in herds, but are nevertheless able to hold their own against the native fauna and even to oust it.

Chital are not free-ranging animals, but when moved out of their usual haunts by some evictive force, they take readily to the altered circumstances of the new setting (TN 64 Apr. 6 and 8) : few animals of a more or less resident normal habitat have a less compulsive sense of territory than chital.

Size : *Morphological characters*

Size varies considerably, as has been said already. The question of size is not dependent so much on the latitude of the chital's range, as has been assumed, as on the nature of the terrain and flora. As fine animals as are to be seen in the Corbett (trans-peninsular) or Kanha N. Ps. are to be seen in the Masinagudi area of the Mudumalai Sa. : it is significant that in the denser adjoining tree forests of the same sanctuary at Kargudi and Theppakkadu, chital display a marked diminution both in size and in the numbers in which they habitually associate, and that even in the Bandipur Sa., contiguous with Theppakkadu, they do not attain the size they do in the Moyar-Masinagudi area. However, it is generally true that size declines from the north to the south of the peninsula.

Colour and patterning of the coat also show considerable variations, probably more dependent on genetical strains than on environment. In the Shivpuri N.P. it was noticed that several stags and hinds carried much larger white spots than is usual (MP 69 Apr. 1 and 2 : photograph MP 25).

In some animals the white spots are noticeably small, and in them the burnt sienna of the surrounding coat has a purplish cast or sheen to it, a cast which does not appear to be directly related to the animal being in breeding condition, though in stags in hard horn the sheen was most apparent (MY 68 Oct. 22, 69 Oct. 12—vide note under this date for a brief account of colour variations noticed). In the fawns the white spots are small and inconspicuous, being partly obscured by the pile of the pelage around them (photograph MY 34).

The black or very dark dorsal median stripe (along the back) was not observed on adult stags in the early stages of velvet, though some of them were of large size, but was seen on stags in hard horn and on adult hinds (not all), even on an adult hind that was heavily gravid : another hind (old) was seen that had no vestige of the dorsal stripe (TN 64 Oct. 2 ; MP 69 Mar. 7 and 10 ; MY 68 Oct. 8 and 21, MY 69 Oct. 12 and 22).

Size and formation of the antlers differ with locality, and are probably dependent mainly on heredity and strain. For example, stags with the widely divergent type of antlers seen in the Kanha N.P. (MP 68 May 3 and 6, 69 Mar. 11 and 18 : photograph MP 6) were not seen elsewhere in the peninsula, except for a few big stags in the Moyar-Masinagudi area of the Mudumalai Sa., which, however, did not have the antlers so widely divergent as some of the Kanha stags, though in point of size their antlers seemed as big or superior (TN 62 Mar. 27, 64 Oct. 4, 69 Oct. 2 : photograph TN 41). Some stags in the Corbett N.P. had antlers as widely divergent as those seen at Kanha.

The best antlers were carried by stags seen in Kanha and in the Masinagudi area of the Mudumalai Sa. ; some stags in the Bandipur Sa., too, had very fine antlers but they were not as big built as the Masinagudi stags. One very stoutly built stag in the Kanha N.P. carried the heaviest antlers I have seen on a chital (MP 69 Mar. 13 : photograph MP 18), and some other stags at Kanha, still in velvet, also had exceptional antlers (MP 70 Mar. 11 : photograph MP 29). Photographs MY 18, MY 27 and MY 29 show a medium-sized stag with fine antlers not yet clear of velvet, and two close-ups of the same reclining stag in hard horn, taken at the Bandipur Sa. I was unable to get a clear picture of a big stag at Masinagudi, though I tried to get one for years. Some stags from that area not only carry very fine antlers but are also magnificently built. The brow tine in stags seen in the south of the peninsula, generally speaking, was poorly developed compared to chital in the Kanha and Corbett parks.

Distribution

I am unable, in spite of diligent inquiry, to collect precise and reliable data on the occupation of the known homes of chital by humanity, and the movements of chital into areas where formerly they were uncommon. While no dependable information is available regarding the probable introduction of chital into the Pt. Calimere Sa., I can say from personal knowledge that when the Raj Bhavan at Guindy was developed, chital from Government House at Mount Road were shifted to the deer park at Guindy, which enjoys the appellation ‘ deer park ’ even today, though the natural faunal feature of the small area is its blackbuck. Another comparatively recent introduction of chital into a littoral area was made by the Raja of Kanika some years ago, and the chital introduced by him into Vhitar Kanika are still there and thriving, in a somewhat exotic setting (O 70 Jan. 27).

Habits : *Behaviour*

The composition of the herd is unstable : large herds split into a number of parties which may reunite in part or whole, or reorganise themselves into new herds (TN 62 Apr. 6). Even chital in comparatively small parties of a dozen or so are liable to change of structure from time to time (TN 64 Sep. 18, Oct. 2, 6 and 7). The large herds are always to be found only where the ground is comparatively open, with maidans and open scrub, and are usually made up of many parties, together for a variable period. Any disruptive influence, such as an acute threat by men or wild dogs, usually scatters such herds into several parties. Chital moving into fresh ground are exceedingly fugitive and wary, and are highly gregarious but on familiar ground may break up into parties and flee, only to reunite (TN 64 Apr. 6). It should, however, be pointed out that the breaking up of a herd into smaller units does not, in itself, establish any inherent instability in the herd. For two reasons, this is so, though these are, to borrow a convenient phrase from the law, mutually exclusive. If a local population is to be taken as a whole, as it can be in chital, which are not far-ranging, it makes little difference whether the component parts of the population are associated in a rigidly fixed manner or in a more changeable and transient association. Again, if a herd is to be considered as a gregarious social unit, it moves and functions as such a unit while it does so, even if it is liable to disruption and reformation. This point is laboured because chital are highly gregarious, and since much of their activity and even repose is based on this gregariousness, it is necessary to realise that their groups associations are not purely accidental.

In fact, the very large numbers of chital seen together in a herd, in areas where the ground is comparatively open, will attest to this basic gregariousness of the deer. A herd I counted at Masinagudi, when it was (for once) possible to count the chital fairly accurately, as they moved more or less in a straggling line up a rise along a track, numbered over 220 : H. Rajagopala Shetty who counted the same herd from a point of vantage where he could see them against the sky as they moved up the rise, had a count of 240+. We were separated by about 2 furlongs and his count, made in more favourable circumstances, was very likely the more correct (TN 62 Sep. 26). A smaller herd seen in the same area, of about 150 chital, could not be photographed together, but a section of it is shown in photograph TN 21 (TN 62 Sep. 23). On several occasions herds of over 100 or 150 chital were seen in the Masinagudi area : even in Bandipur, some large herds were seen, although the less open forests here do not encourage large herds to the same extent (MY 68 Oct. 7, 25, 69 Oct. 12, 22 : photographs MY 15, MY 20, MY 28 and MY 34). In Kanha, too, some fairly large herds were seen. In the Corbett N.P., where the chital emerge from and retreat into the sal cover in small parties in the evenings and mornings (respectively) they are not found in large herds within the sal cover, but once they are out in the open, they associate in large numbers.

In no deer do the groups of adult males, variously termed schools of stags and stag-parties, attain the numerical size that they do in chital. Naturally, since chital are found in large herds only in comparatively open country, in the tree forests where they do not occur except in parties of from 3 or 4 to two dozen, large stag-parties cannot be expected. In barasingha (*Cervus duvauceli duvauceli* and *C.d. branderi*), stag-parties are known and have been described, but though these appear to have been comparatively large in the past, today the dominantly male associations seldom seem to attain a strength of even 50. In chital, a herd of stags may number over 100 and be entirely male, or contain a few old hinds or even a few subadult females which do not alter the overwhelmingly male character of the association. Such large stag-parties were repeatedly observed in the Masinagudi area of the Mudumalai Sa., and nowhere else (TN 62 Sep. 25, 64 Oct. 4 : photograph TN 41, 66 Sep. 16 and 17, 66 Oct. 2). In other places stag-parties seen were comparatively small, containing only some 4 to 10 animals (MR 69 Nov. 16 : photograph MR 8 ; MP 70 Mar. 5 : photograph MP 30). J. Mishra commenting on such parties of stags in the Palamau N.P., informs me that in all parties seen, the stags were in velvet. This must have been a coincidence. In herds of stags, as also in large mixed herds, all stages of antler development were observed, some stags having polled heads (having just shed their antlers), some being in the early stages of regeneration with the swollen tine-tips covered with velvet, some in the penultimate stage with the antlers fully developed but still covered with velvet, and some in hard horn : even in small stag-parties, usually some animals were in velvet and some in hard horn (TN 62 Sep. 13, 63 Sep. 25; MR 69 Nov. 16—photograph MR 8).

This lack of a season for antler-shedding is perfectly in accord with the fact that breeding is not confined to any season but takes place throughout the year. This may be further proved (apart from the stags being in velvet and in hard horn throughout the year) by the fact that young fawns may be seen at any time of the year. Some observers have, while conceding the fact that breeding takes place practically throughout the year, postulated a peak breeding season. Schaller, after agreeing with me that at Kanha the rut continues throughout the year, adds that sexual activity increases greatly from March to June with a peak in May. The evidence he cites includes the braying of the stags as denoting their sexual excitement. Undoubtedly braying does have a basic sexual significance, but it also seems to have a purely social function : it is invariably indulged in by a stag which, whether it is in the company of other stags or not, seems to be feeling alone, and on joining the herd or a party, or even some other stags, the braying is given up (MP 69 Mar. 9; B 70 Mar. 2). Further, the number of brays heard on successive days from a standpoint in the Kanha meadow seem to be no dependable indication of the number of stags actually braying, for fortuitous circumstances condition the record (MP 69 Mar. 8 ; vide notes). An aspect of braying by the stags as being an indication of sexual excitement that does not seem to have been considered by observers so far is that it seems to be commoner in some areas than in others : for example, it is much less common in the Masinagudi areas and in Bandipur (where the chital populations are considerable) than in the Kanha or Palamau N.Ps. Why this should be so I do not know. It will be necessary to investigate brayings all round the year in all such areas before any reliable data can be considered.

A necessary consequence of breeding being spread out over the entire year is that at no time are a large number of very young fawns seen with the adults. If breeding was defined and seasonal, such a noticeable proportion of very young fawns would be inevitable, for in order for the species to survive it must reproduce adequately, but naturally, with reproduction diffused over the year, the number of infants is at no time sharply apparent or conspicuous. I consider this adequate proof of there being no breeding season.

Schaller provides a description of the various attitudinal displays that serve in intraspecific communications in chital : these are specially noticeable in captive chital in a paddock, and not merely because they are most readily observed : it may be said that their main function, when they are threat displays, is to avoid actual conflict when a gesture of domination is responded to with a submissive gesture.

Both the head-up and head-down displays are indulged in, the former more commonly by hinds (which may, in continuation of a mutual head-up, rise on their hind legs and strike out at each other with their forelegs—MY 68 Oct. 7) and the latter by the stags ; however, both displays are much less frequent among wild chital than among chital in captivity : this is difficult to understand because, in wild chital, where the dominance values have already been established in a herd, these displays are uncommon, and in a paddock dominance values are well established for the time being. In a herd, stags in hard horn naturally take precedence over stags in velvet, even a brocket over a big stag in the early stages of velvet. When 2 stags of a size, both in hard horn, are moving more or less side by side, they sometimes walk stiffly, with the head slightly averted at the stretch of the neck, and roll their eyes (displaying the white of the eye) from time to time—apparently such stags are maintaining an armed neutrality towards each other (MY 69 Oct. 14 : photograph MY 25 shows a brocket adopting this gait and attitude while walking besides another brocket which is biting at its hind quarters). One light-coloured stag with distinctively short and upcurled brow lines, running with a hind, threatened other stags that came too near with a curious demonstration which exactly duplicated the demonstration aimed at us and the riding elephant by the big bull of a herd of wild buffaloes in Kaziranga : this stag lowered his antlers and leaped forward towards the intruder, not following up the leap with a lunge, but braking it with

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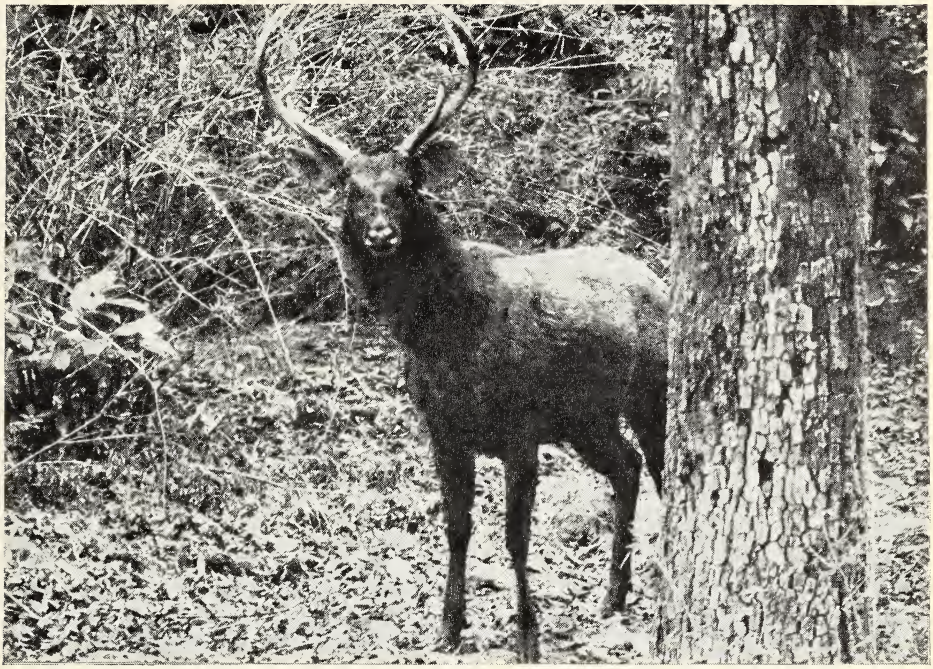
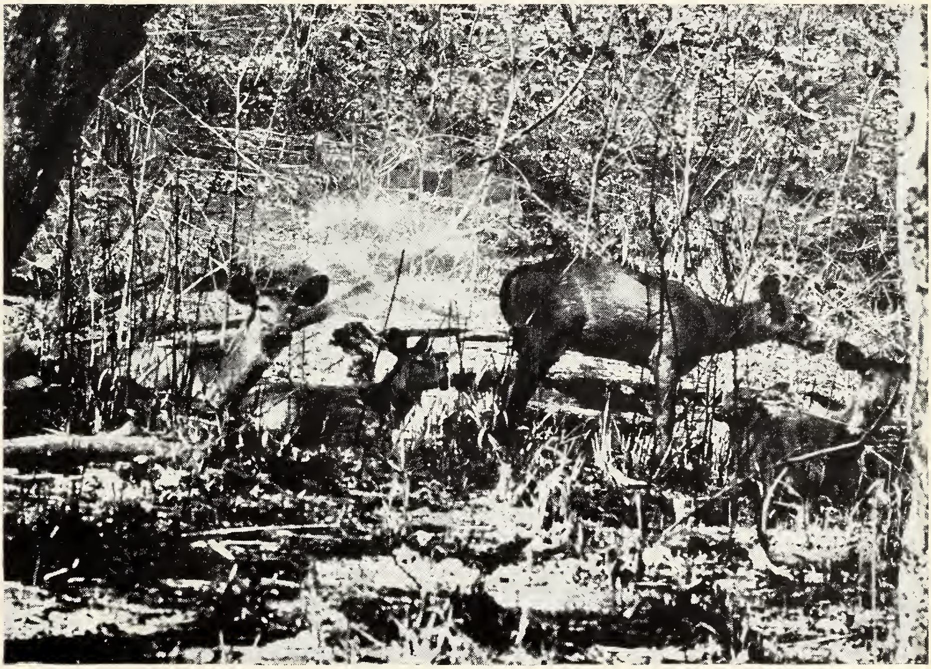
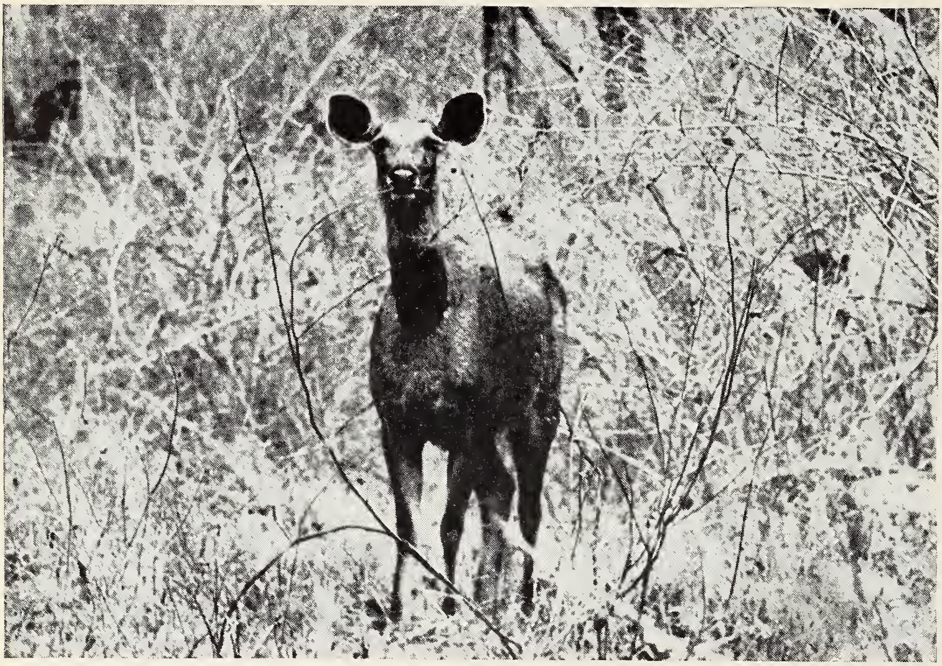
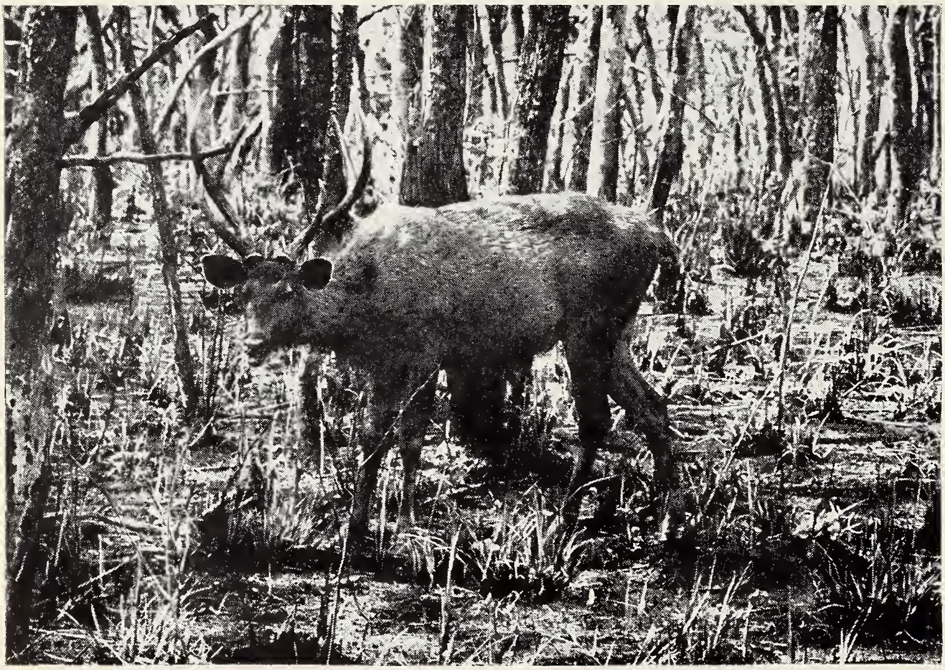




Above : TAMIL NADU 1963 : MUDUMALAI SA. : Kargudi : April 3 — p.m. : The big sambar stag alert with suspicion — TN. 26 ; *Below :* TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : April 5 — 11.30 a.m. : Sambar by the fire. Note smoke — TN. 35.

(*Photos : M. Krishnan*)





Above : TAMIL NADU 1966 : MUDUMALAI SA. : Kargudi : April 9 — p.m. : Sambar hind clearly showing the sore-patch and the white mouth of the opening in the middle — TN. 44 ; *Below :* TAMIL NADU 1966 : MUDUMALAI SA. : Kargudi : April 19 — a.m. : Sambar stag in the dry forest — TN. 45.

(*Photos : M. Krishnan*)

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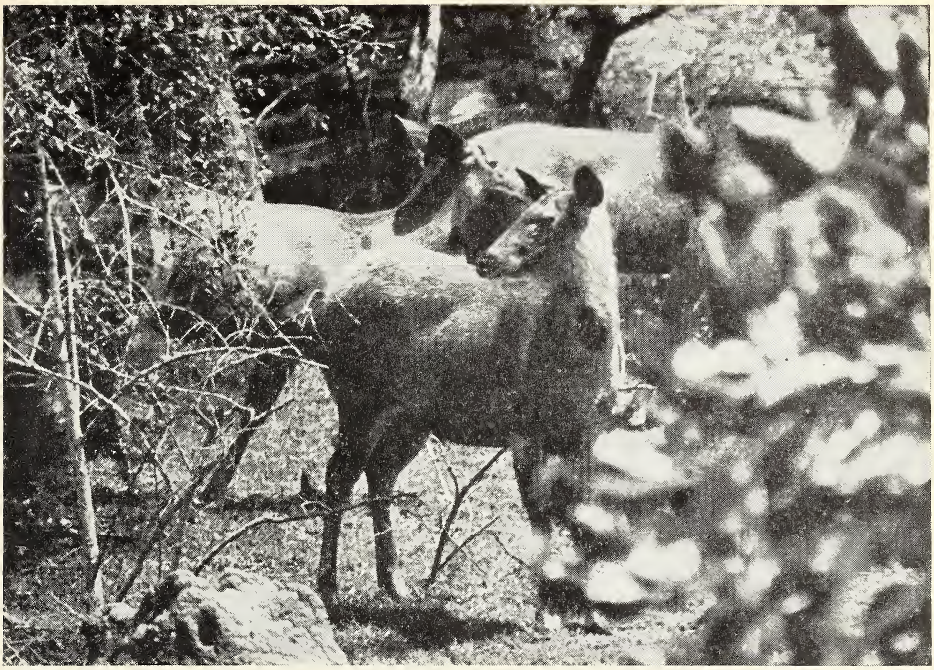
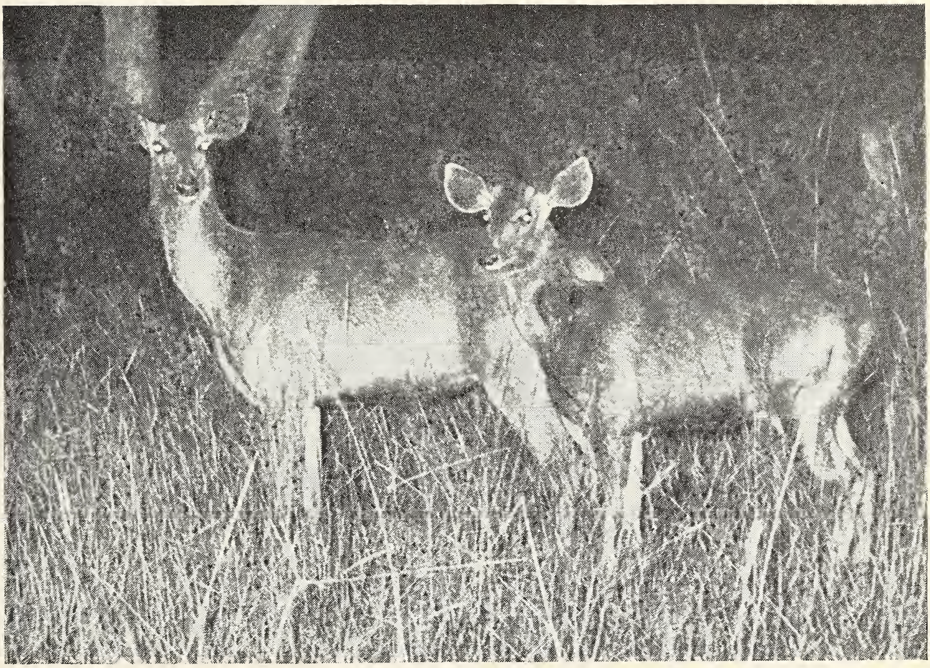
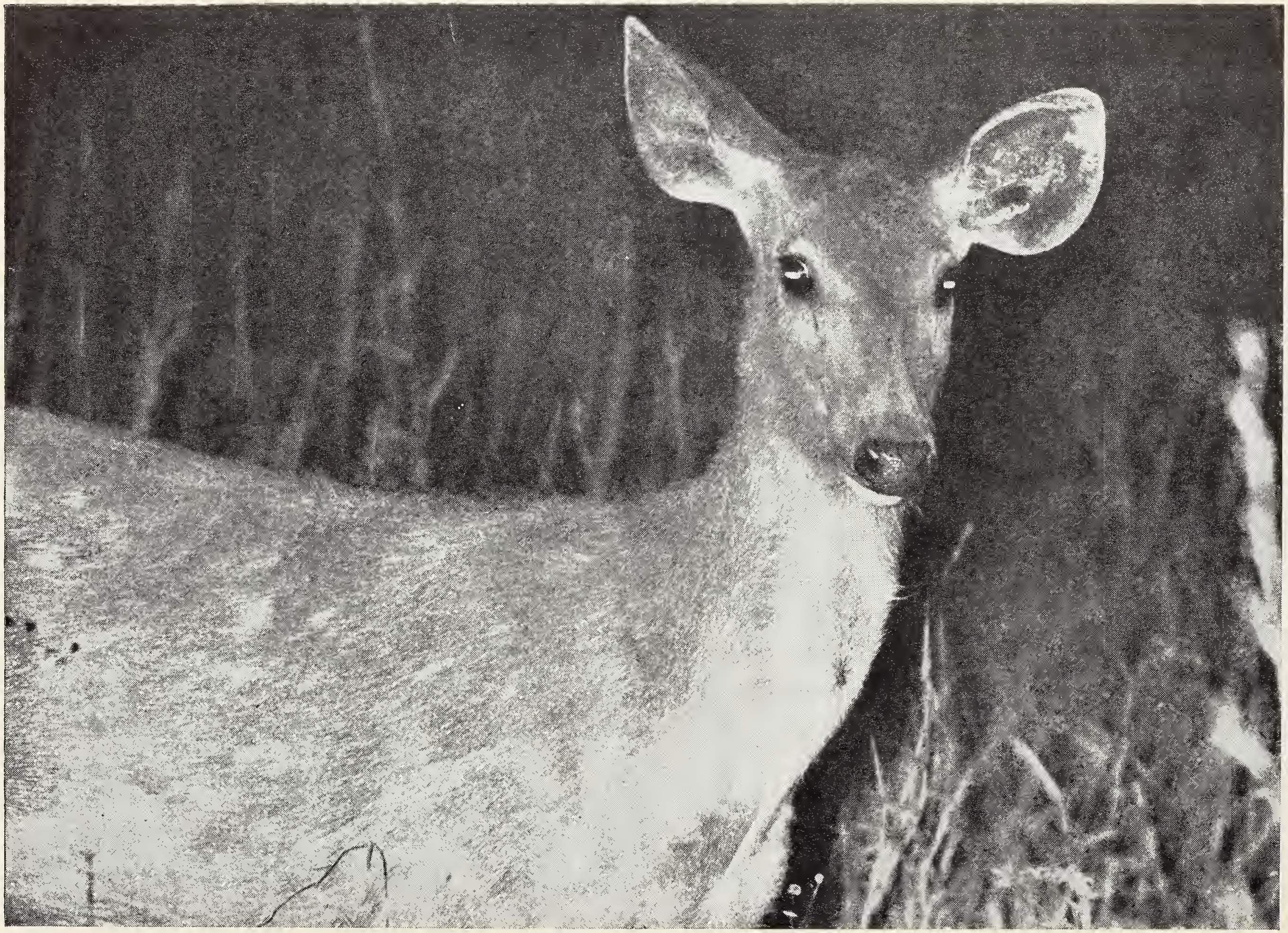




Above : TAMIL NADU 1970 : MUDUMALAI SA. : Masinagudi : September 16 — p.m. : Young sambar hind — TN. 59; *Below :* MAHARASHTRA 1969 : TAROBA N.P. : November 19 — about 7 p.m. : Sambar hind and young (male) — MR. 10.

(*Photos : M. Krishnan*)



BIHAR 1969 — HAZARIBAGH N.P. : February 14 — 7 p.m. : Portrait of a sambar hind. Note the whorl of hair on the throat and the absence of a sore-patch — B. 7.

(Photo : M. Krishnan)

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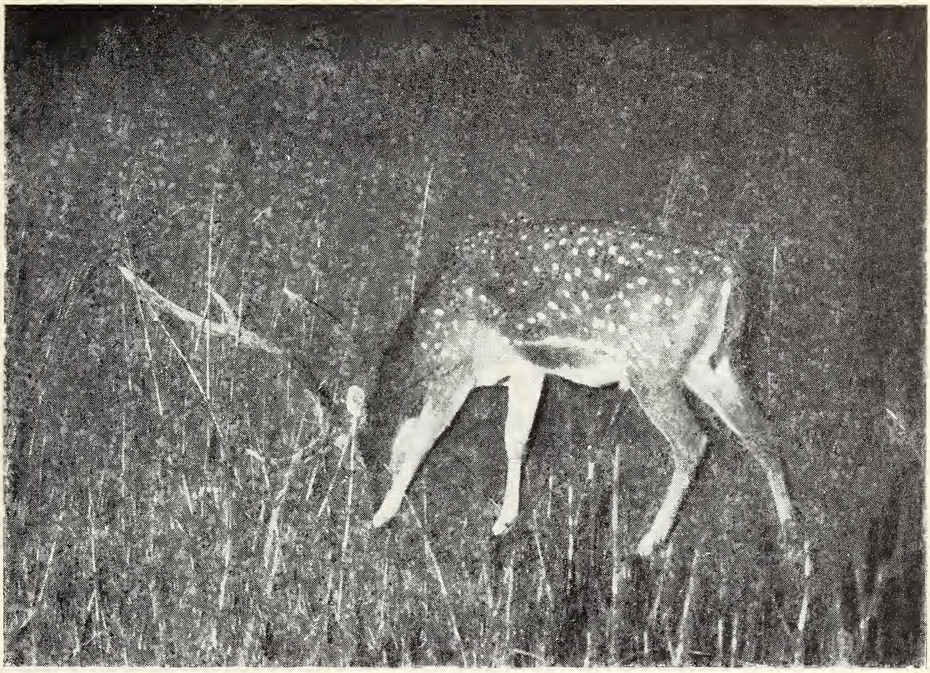
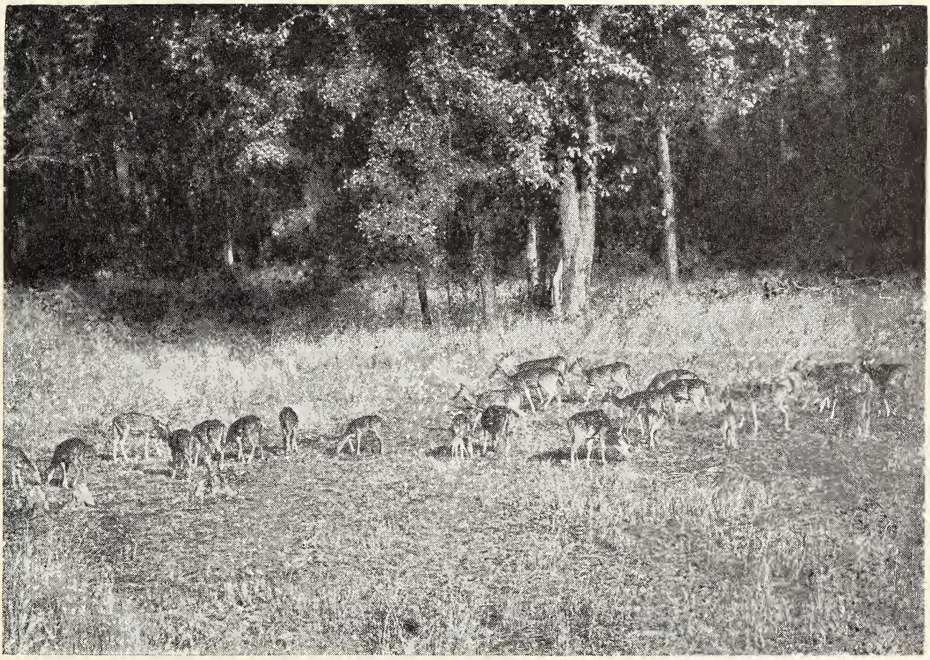
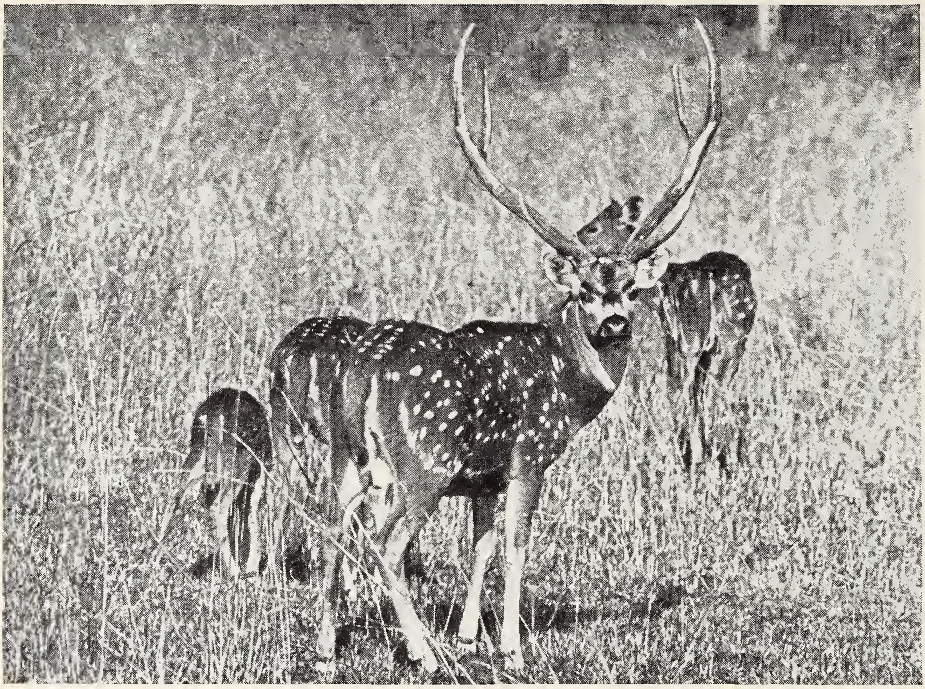


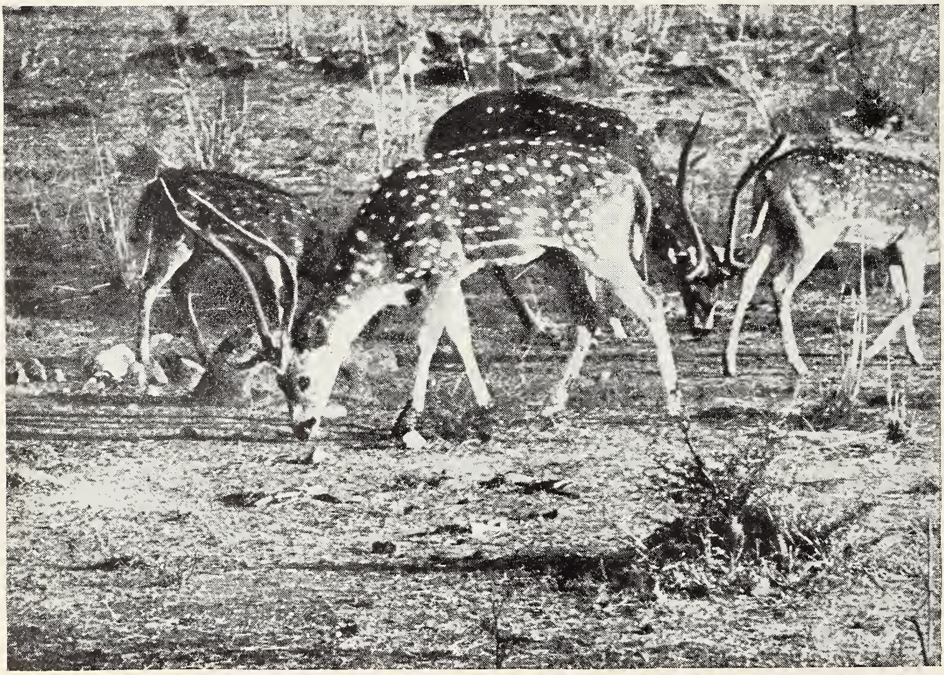


Above : M.P. 1969 : KANHA N.P. : March 10 — night : A chital stag with fine antlers feeding on the roadside — MP. 16 ; *Below* : M.P. 1969 : KANHA N.P. : March 12 — a.m. : 2 parties of chital near each other in passing — MP. 17.

(*Photos : M. Krishnan*)

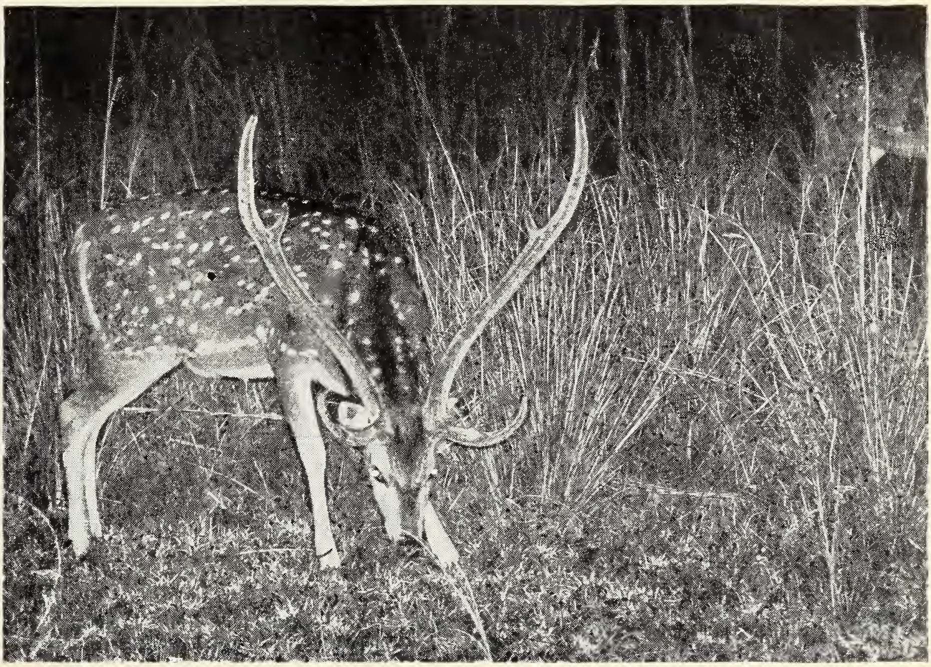
Krishnan : Mammals

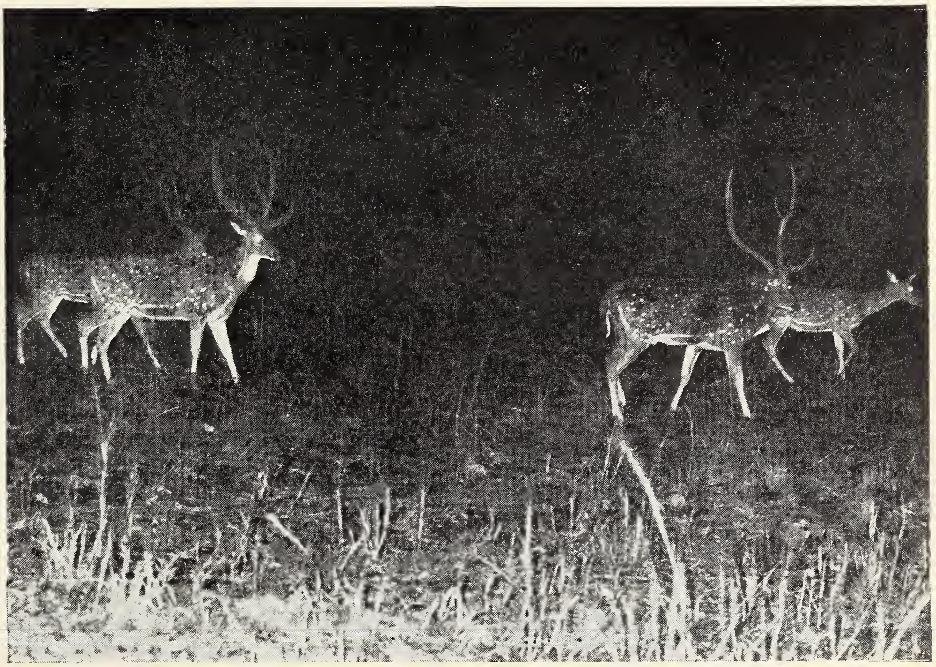




Above : M.P. 1969 : KANHA N.P. : March 13 — p.m. : The big chital stag : Note massive antlers — M.P. 18 ; *Below :* M.P. 1969 : SHIVPURI N.P. : April 2 — p.m. : A chital stag showing very large white spots — M.P. 25.

(*Photos : M. Krishnan*)

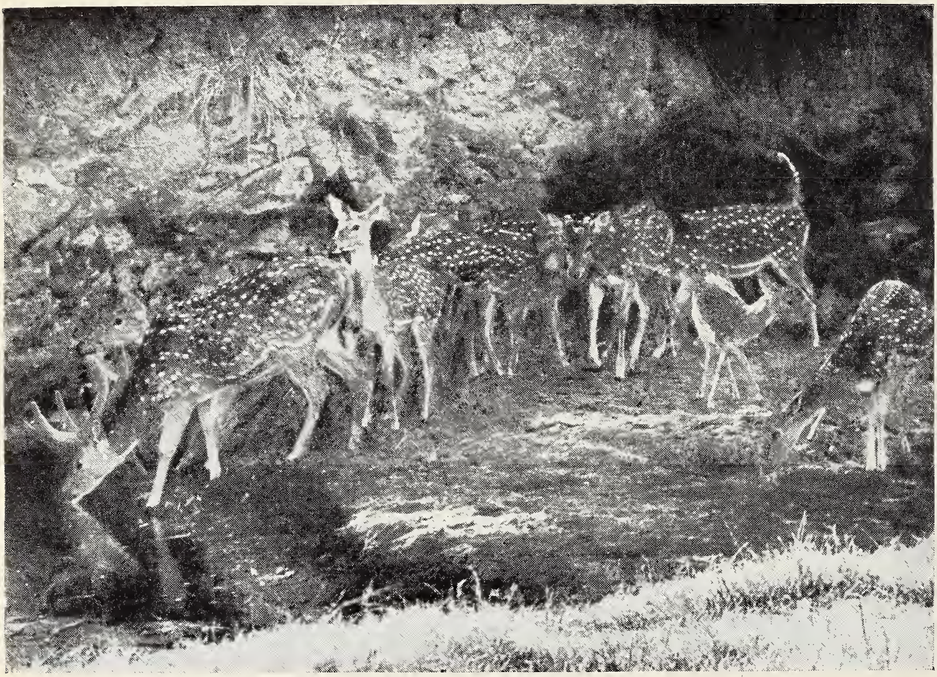


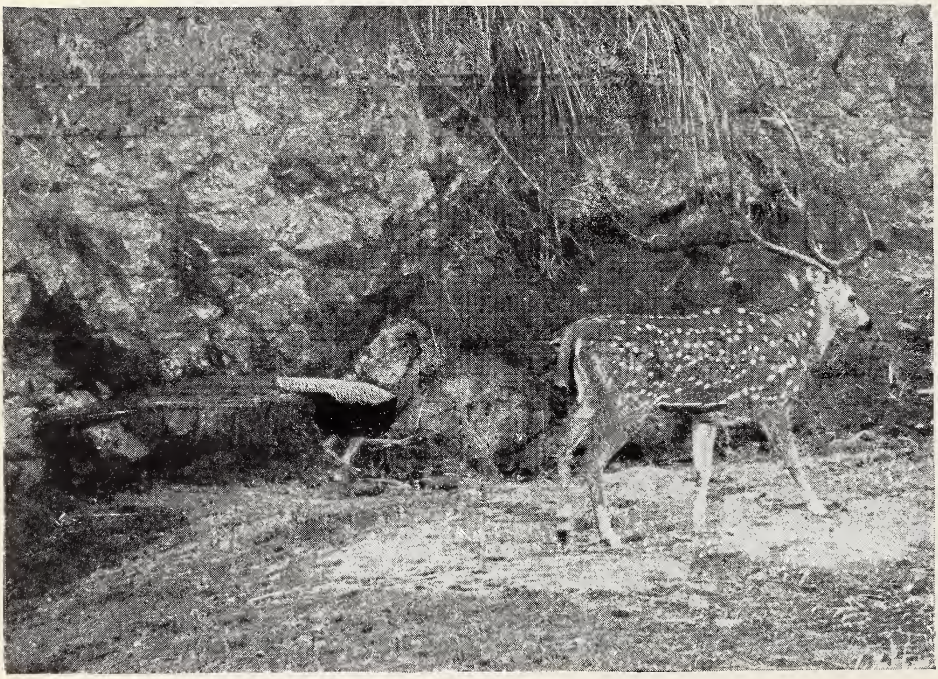


Above : M.P. 1970 : KANHA N.P. : March 11 — 7.45 p.m. : A chital stag in velvet grazing : Note exceptionally fine antlers — M.P. 29 ; *Below* : M.P. 1970 : KANHA N.P. : March 11 — 8 p.m. : A party of chital stags — M.P. 30.

(*Photos : M. Krishnan*)

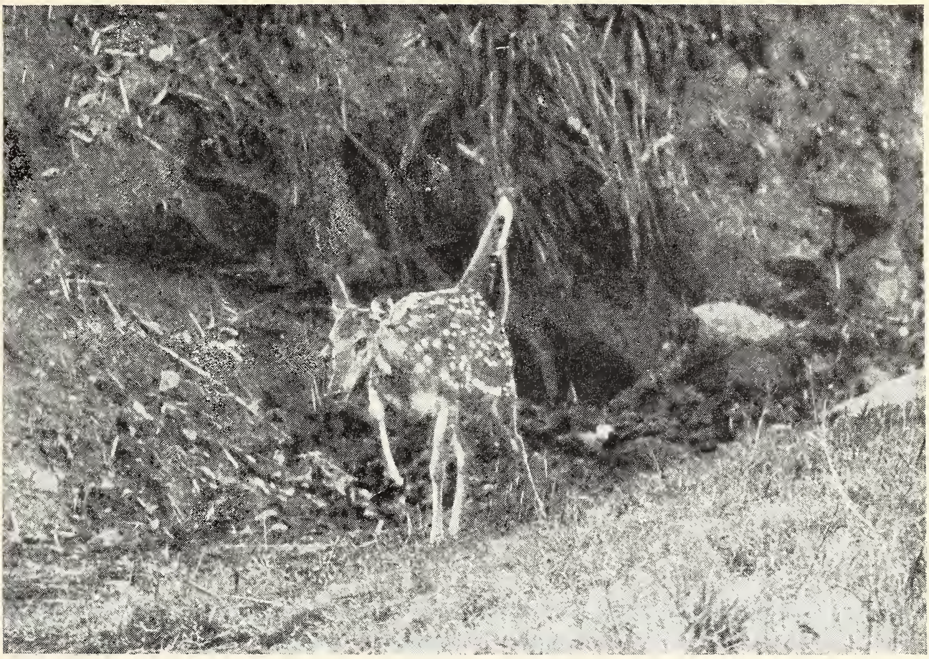
Krishnan : Mammals

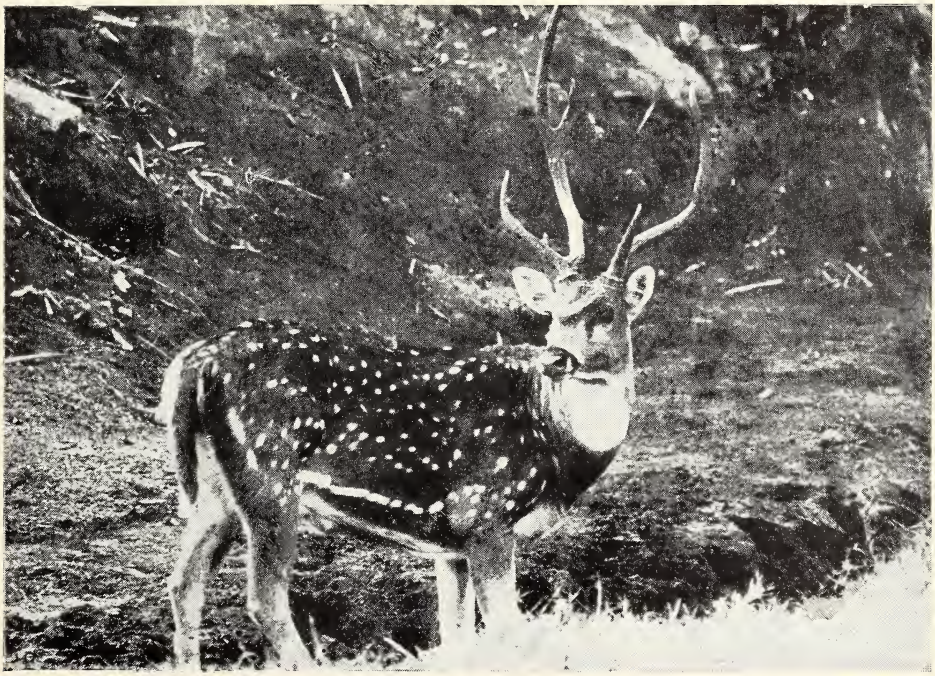




Above : BIHAR 1969 : BETLA : PALAMAU : February 21 — 9.30 a.m. : Chital drinking at Madhuchuan — B. 13 ; *Below :* BIHAR 1969 : BETLA : PALAMAU : February 25 — a.m. : Chital and peacock leaving the water at Madhuchuan after drinking — B. 17.

(*Photos : M. Krishnan*)

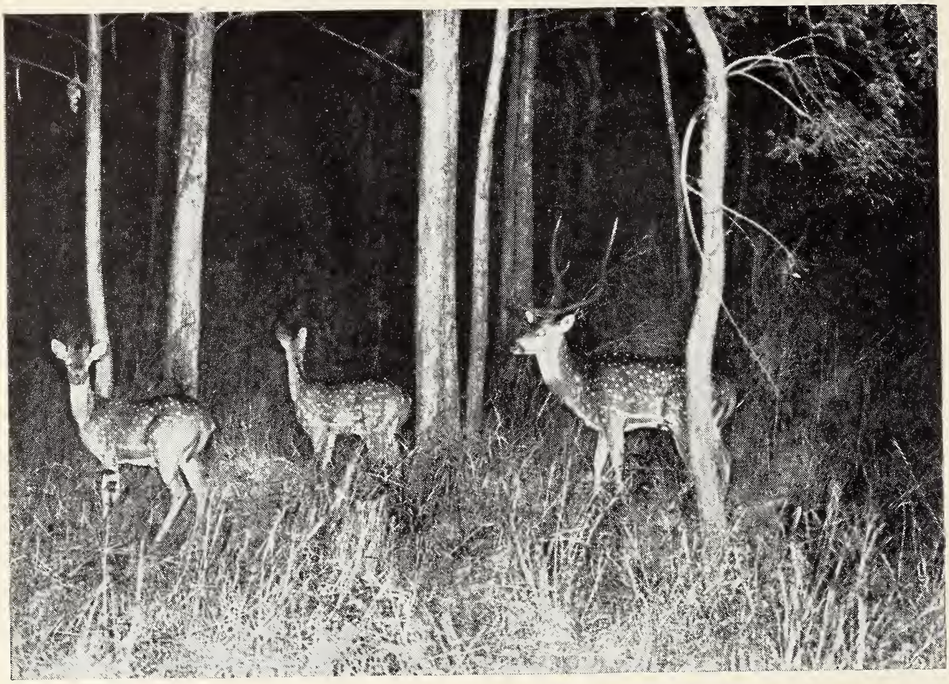


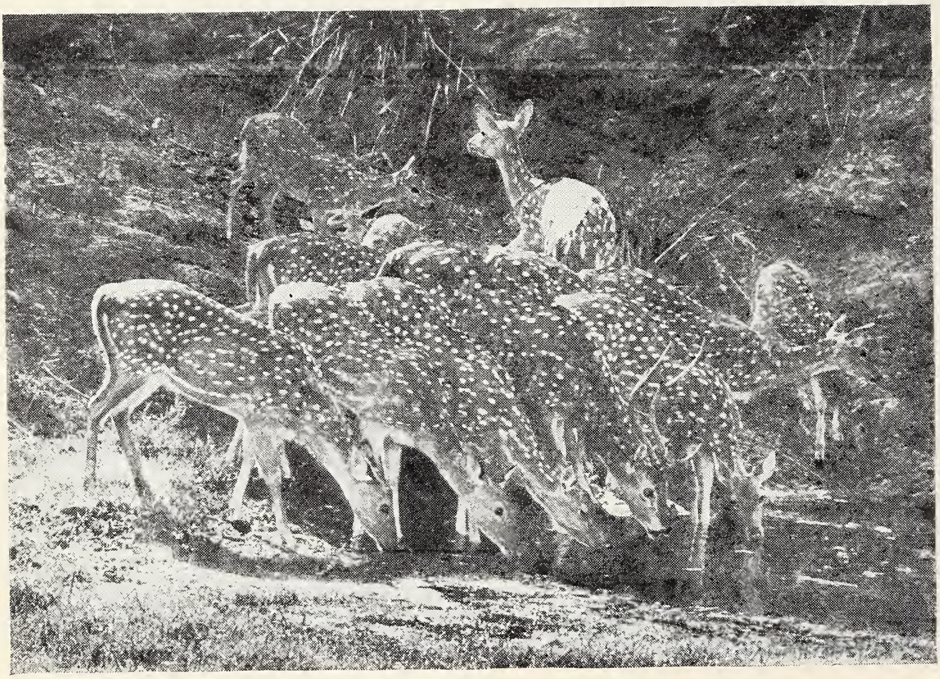


Above : BIHAR 1969 : BETLA : PALAMAU : February 25 — a.m. : Chital hind at Madhuchuan stamping her forefoot — B. 18 ; *Below :* BIHAR 1969 : BETLA : PALAMAU : February 26 — a.m. : Limping stag with unequal antlers, Madhuchuan — B. 19.

(*Photos : M. Krishnan*)

Krishnan : Mammals

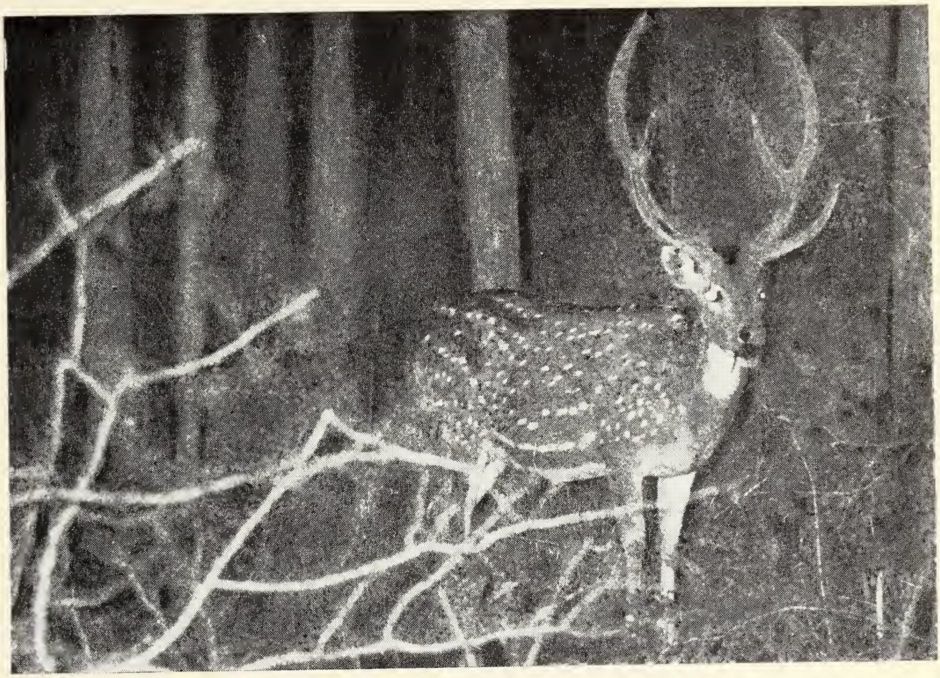


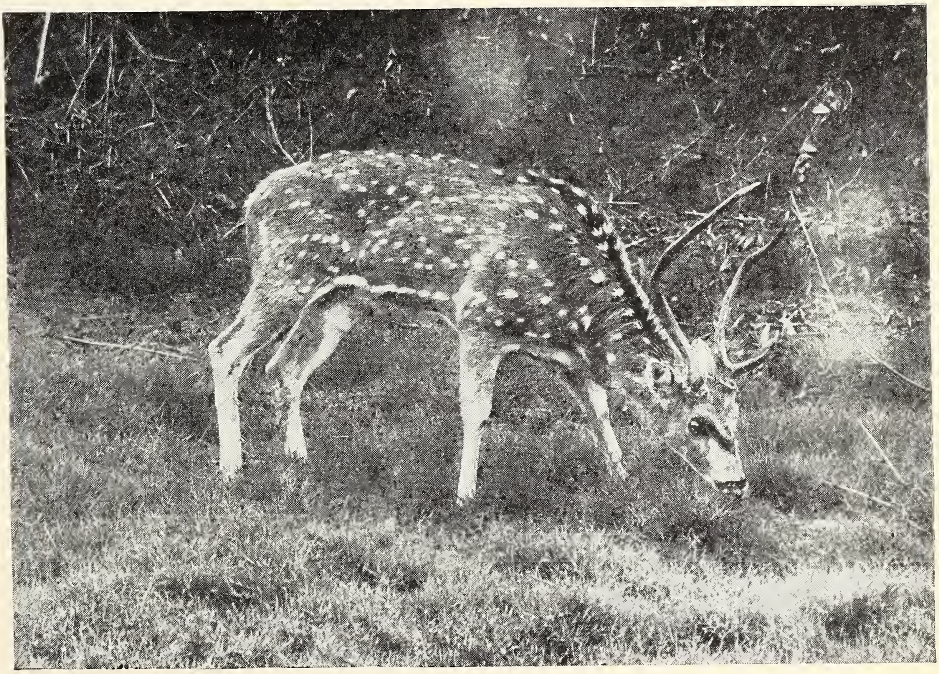


Above : BIHAR 1970 : BETLA : PALAMAU N.P. : February 21 — about 8 p.m. : Chital — B. 31 ; *Below* : BIHAR 1970 : BETLA : PALAMAU N.P. : February 23 — 7.10 a.m. : Chital drinking at Madhuchuan — B. 33.

(*Photos : M. Krishnan*)

Krishnan : Mammals

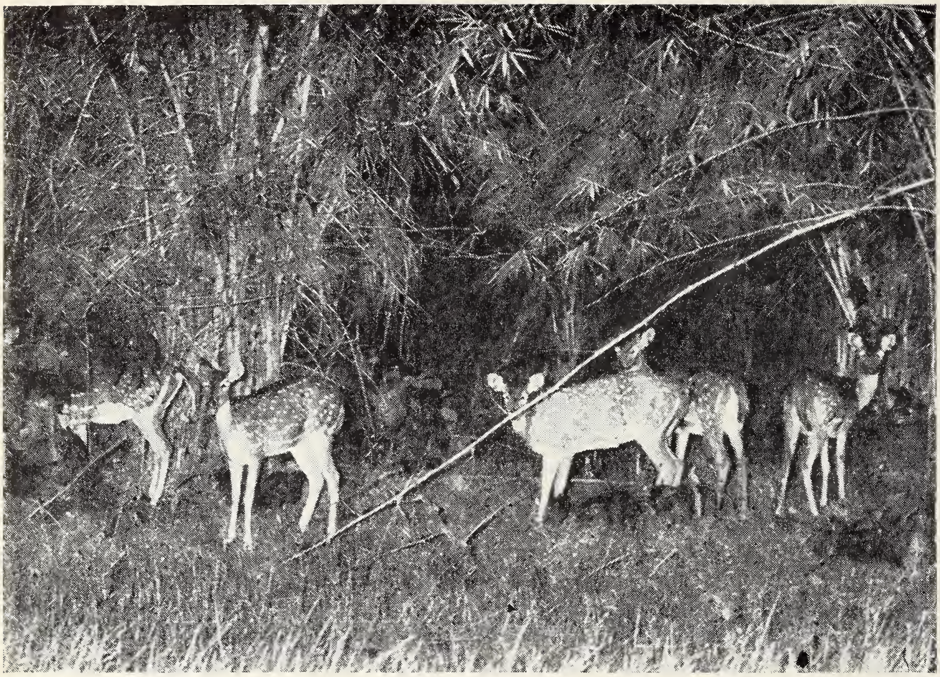


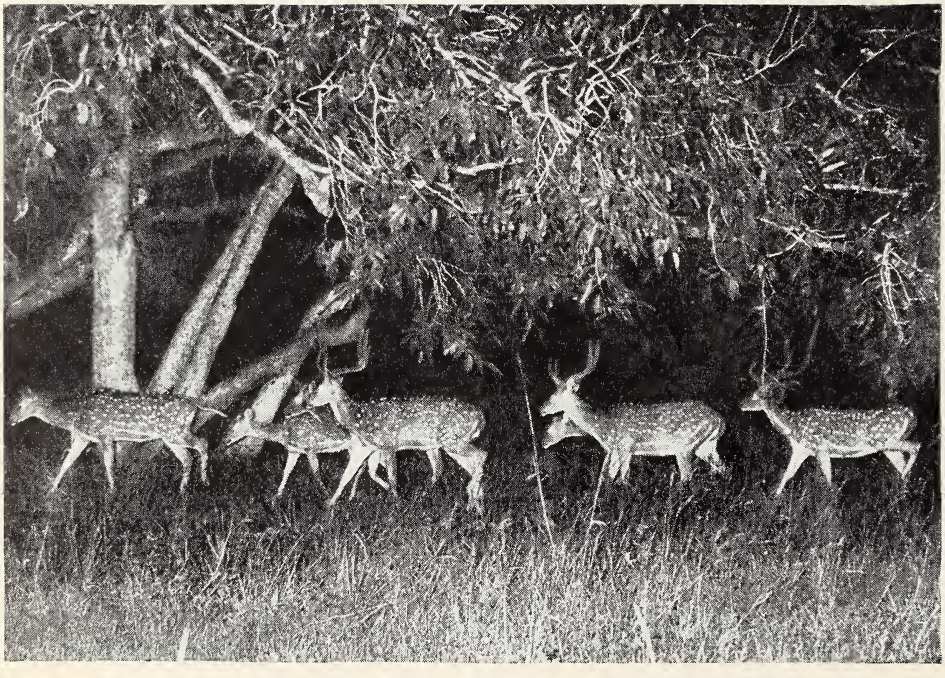


Above : BIHAR 1970 : BETLA : PALAMAU N.P. : February 26 — about 7.30 p.m. : Chital stag eating bael fruit — B. 35 ; *Below :* BIHAR 1970 : BETLA : PALAMAU N.P. : February 28 — 10.30 a.m. : The limping stag — B. 36.

(*Photos : M. Krishnan*)

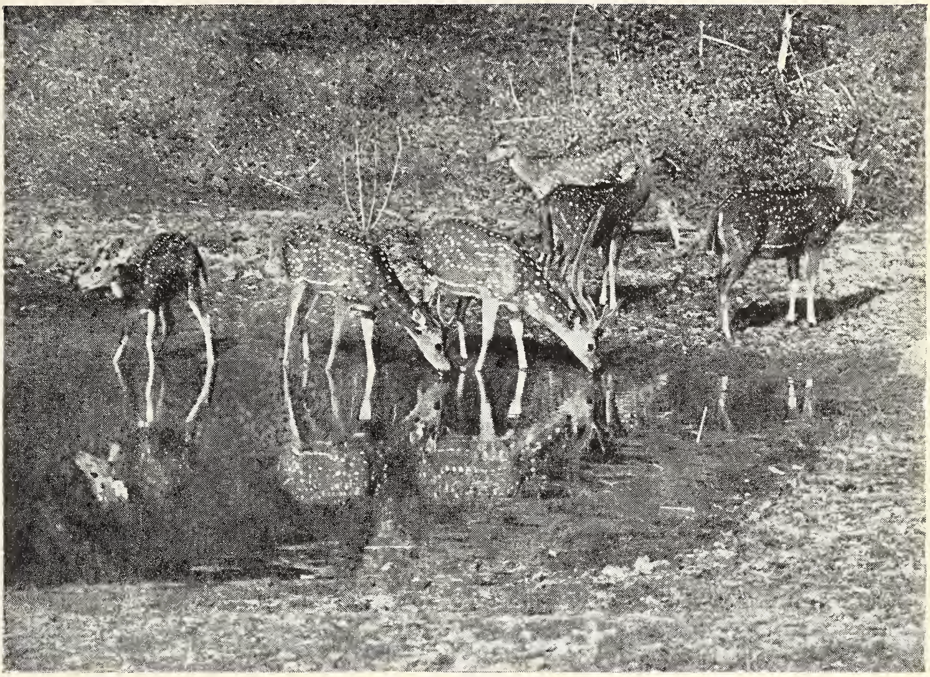
Krishnan : Mammals

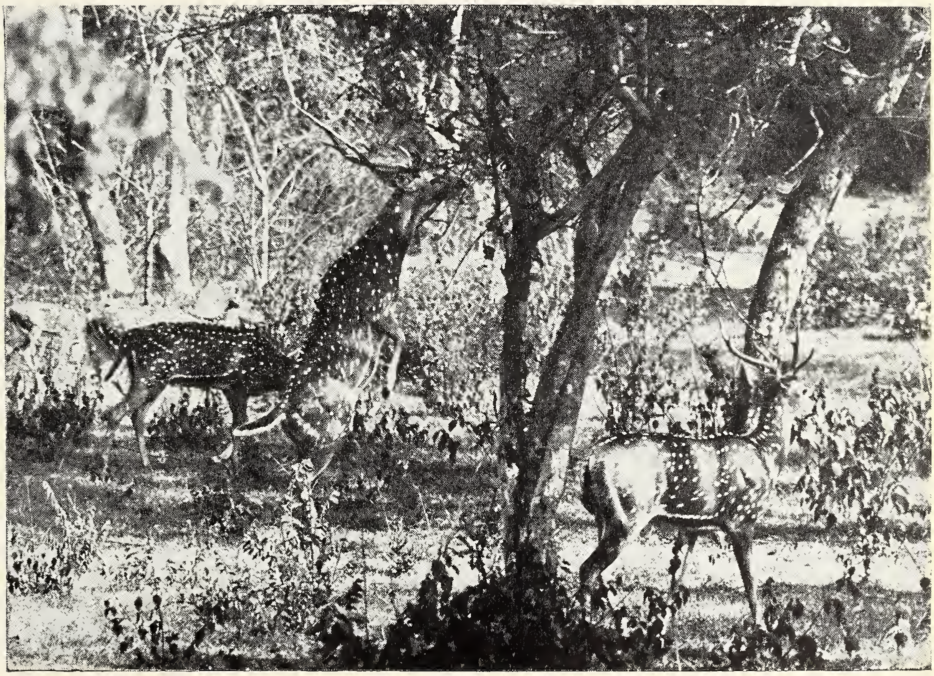




Above : MAHARASHTRA 1969 : TAROBA N.P. : November 15 — about 7.30 p.m. : Chital in bamboo cover : Chital Road : MR. 7 ; *Below :* MAHARASHTRA 1969 : TAROBA N.P. : November 16 — about 7 p.m. : stag-party — MR. 8.

(*Photos : M. Krishnan*)

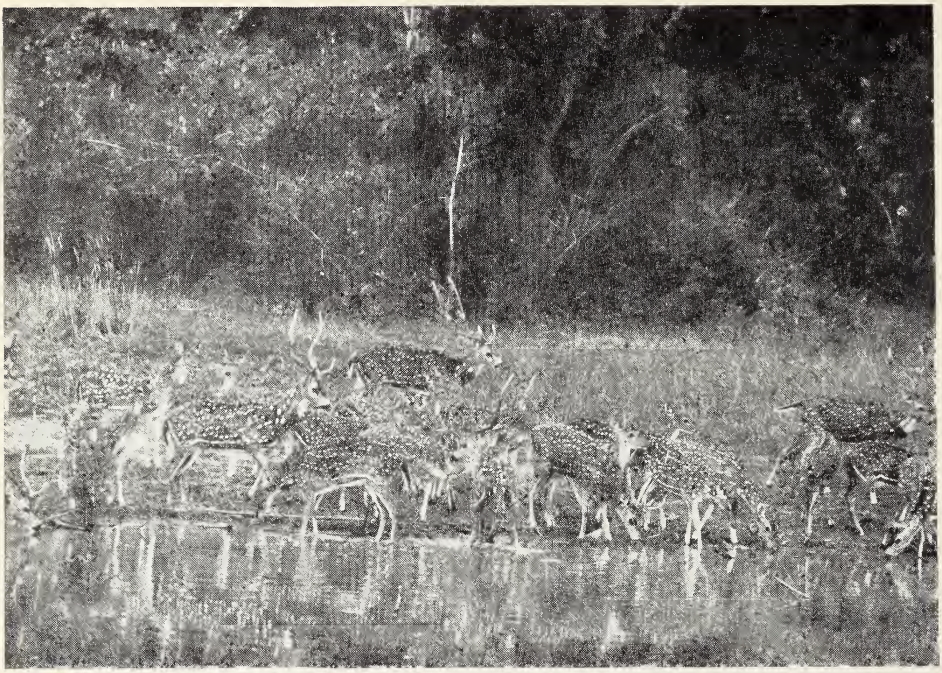


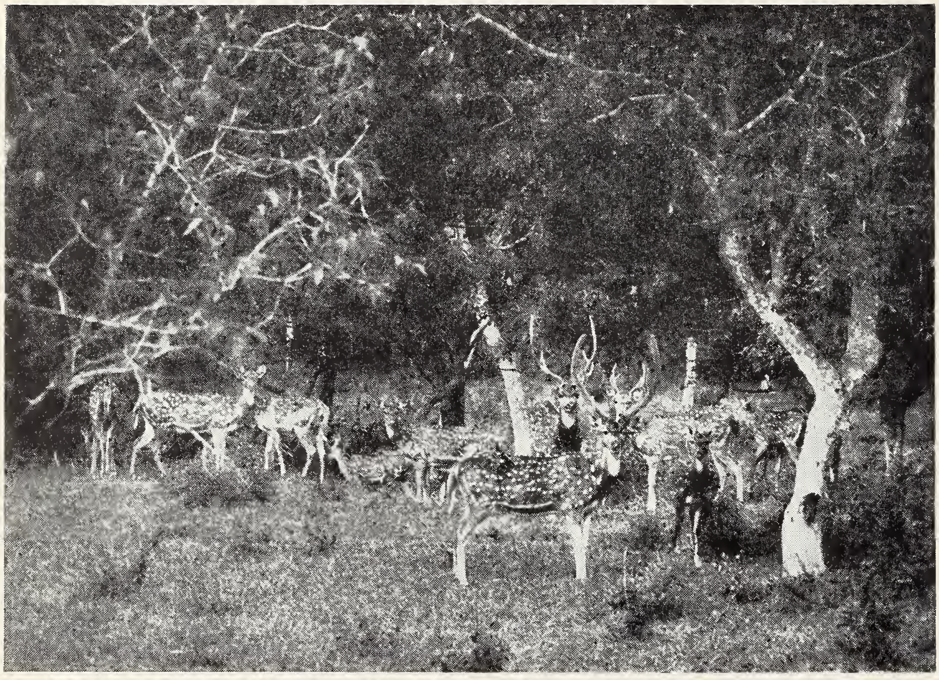


Above : MYSORE 1968 : BANDIPUR SA. : October 8 — a.m. : Chital drinking — Baisanapur Keré — MY. 1 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 8 — a.m. : Chital eating tree foliage (*Emblica* sp.) — MY. 2.

(*Photos : M. Krishnan*)

Krishnan : Mammals

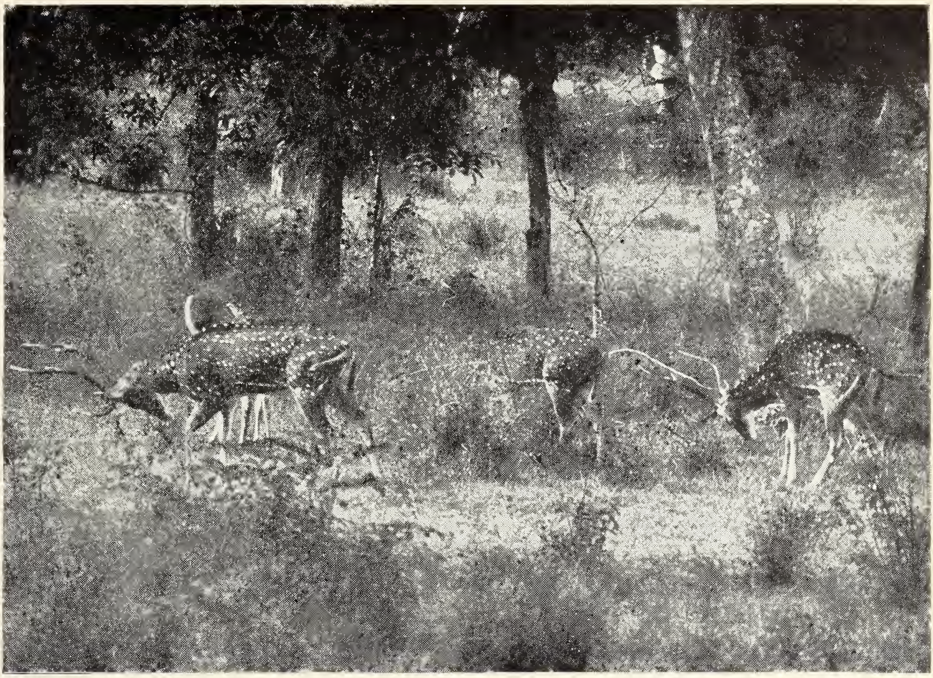


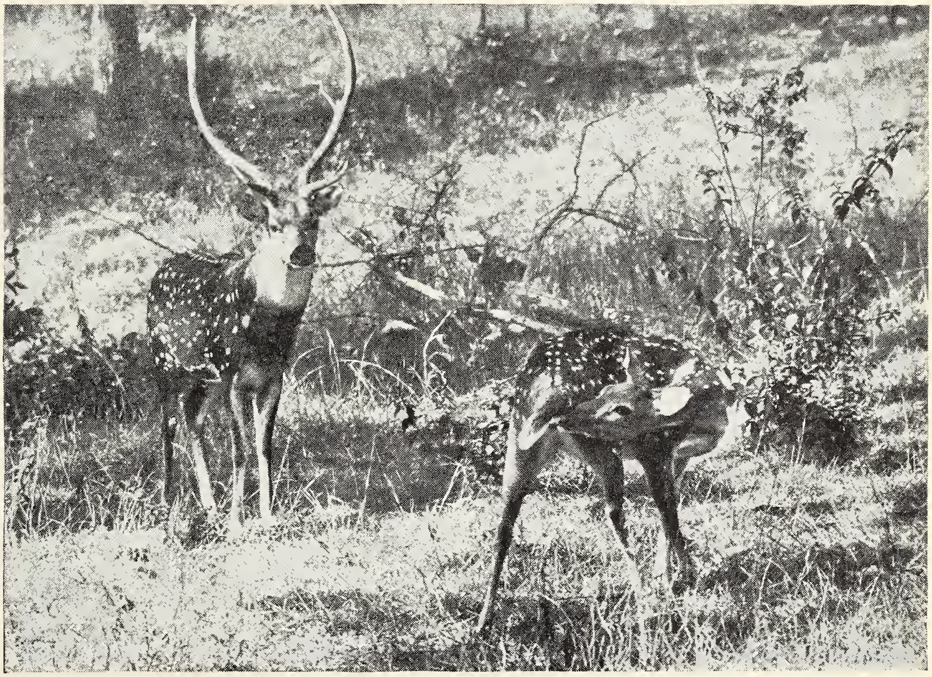


Above : MYSORE 1968 : BANDIPUR SA. : October 11 — p.m., towards sunset : Chital drinking at Sullukatté — MY. 8 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 23 — a.m. : stags in velvet and in hard horn — MY. 12.

(*Photos : M. Krishnan*)

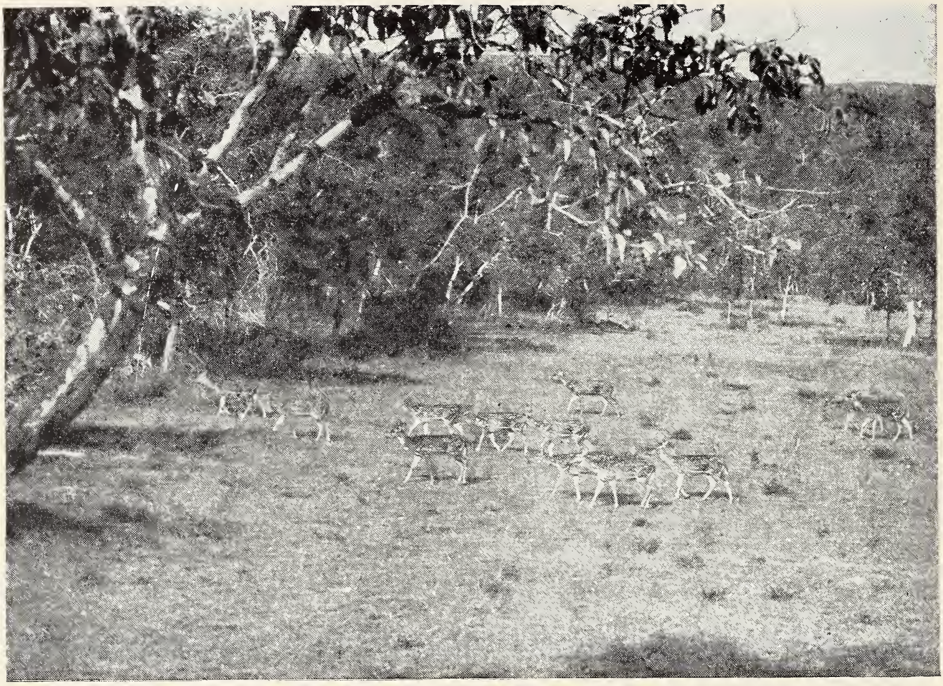
Krishnan : Mammals

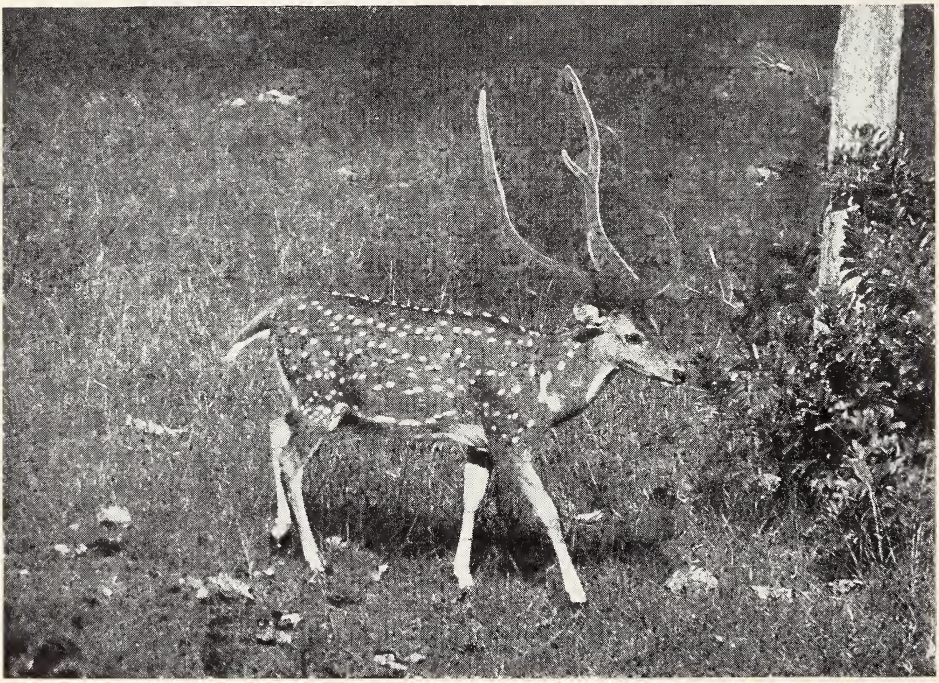




Above : MYSORE 1968 : BANDIPUR SA. : October 23 — a.m. : Stags thrashing bushes — MY. 13 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 24 — a.m. : The stag and hind that were together in a pair — MY. 14.

(*Photos : M. Krishnan*)





Above : MYSORE 1968 : BANDIPUR SA. : October 25 — a.m. : Chital crossing a maidan — MY. 15 ; *Below :* MYSORE 1968 : BANDIPUR SA. : October 26 — 8.30 a.m. : Stag with long antlers in velvet — MY. 18.

(*Photos : M. Krishnan*)

stiffly braced forefeet and coming to a rocking halt (MY 69 Oct. 22). Another stag, bigger and darker, also running with a hind, intimidated stags that came near with a head-down display, and sent the light-coloured stag running with a mere, pointed look without any display (MY 69 Oct. 22 : photograph MY 31). Young stags (naturally, only those in hard horn) indulged in brief bouts of sparring (MY 69 Oct. 14 : photograph MY 26) and older stags in hard horn with well-developed antlers occasionally thrashed the bushes (MY 68 Oct. 23 : photograph MY 13) which, apparently, is a form of redirected aggression, or a demonstration.

The most commonly used display to move other chital was not attitudinal but purely ocular. Chital are not unique in using a sharp, pointed direct look, or a sideways glare, as a means of intraspecific communication : barasingha and sambar also use them, and the direct glare of some of the greater cats at a human intruder, with the head raised high, is also basically similar, though not intraspecific in its communication. However, the use of the rolled eye (to display the white) without any attitudinisation, and of a pointed glare to direct a subordinate are specially noticeable in wild chital (MY 68 Oct. 8, 69 Oct. 14 and 22).

The bite-threat was commonly used by hinds towards one another, and once by a brocket towards another (MY 69 Oct. 14).

A threat or demonstration common to most horned animals, and freely indulged in by stags (directed at other stags, usually) is the lowering of the antler or horn and a lunge forward. This was noticed several times. In gaur the threat sometimes results in a sharp prod, but in chital the gesture was more formal, and I did not see any stag indulging in this demonstration prod the threatened stag.

The purpose of these attitudinal and ocular displays, and these demonstrations, is presumably to avoid actual physical conflict in a gregarious association, and also to serve as an expression of dominance : displays of the acceptance of such assertions of dominance and expressions of subordination are also well-known, the commonest of them being retreat by the subordinate animal : a more formal submissive display is a sudden preoccupation with grazing. In chital, sometimes the aggression of a stag in a herd towards another is not merely a threat or a demonstration, but a sharp attack which, if not avoided swiftly, may result in a bad goring.

It is necessary to make this point more fully, because in few animals are serious injuries caused by such sudden attacks so common as in chital, and the point does not appear to have been commented on before. Wherever chital are a prominent feature of a faunal area, a number of limping stags may be seen, usually by themselves or with another stag or two, but sometimes in a herd (MP 68 May 1 and 5; MY 68 Oct. 5;

MP 69 Mar. 8, MY 69 Oct. 23). In some of these limping stags, gored wounds were seen. Where it is very badly wounded (and even a casual lunge with a chital's antler can cause deep, punctured wounds), the stag gored usually is by himself, and often found lying down in cover (MP 69 Mar. 8 and 13—very probably the same stag). Such an injury might result in permanent lameness (B 69 Feb. 24 and 26, and B 70 Feb. 28 : photographs B 19 and B 36: the photographs show the same lame stag after the lapse of a year : he was still lame, and his antler, *opposite* the side on which he was injured, was still malformed). In the last instance, of course, it was not established that the injury was the result of a goring by another stag, but it was very probably that, for reasons stated in the next paragraph.

Sudden attacks by one stag in a herd or party on another, resulting in a deep, gored wound, were actually witnessed (MY 68 Oct. 22, MY 68 Oct. 27 and MP 69 Mar. 13). Only in one of these instances was the attacking stag running with a hind (photograph MY 14) : stags running with hinds are very intolerant of the presence of other stags, even of brockets (TN 64 Oct. 2 and 6). Stags with hinds do attack other stags, and may be attacked by another stag attracted to the hind in season, and fights between stags may result even in the death of one of them. J. Mishra has provided me with a circumstantial account of such a death, wherein it was proved, as conclusively as possible in a post mortem investigation, that the cause of death was gored wounds inflicted by another chital stag—this was in the Palamau N.P.

Though many of its intraspecific communications are visually apprehended, the chital's eyesight is only fair, and it is not quick at making out immobile objects (TN 64 Apr. 12) : its night vision appears to be less acute than that of blackbuck (MISC 60 June 8). However, it does normally seek visual confirmation of danger apprehended through the other senses.

Hearing is probably more acute than is generally appreciated. Chital do listen for many sounds, their own intraspecific calls, and the alarm calls of other animals. In the Bandipur Sa., where the alarm calls of peafowl may be commonly heard, every chital in a large herd was alerted and turned towards an alarm sounded by a peacock (which, to my ears, seemed no more urgent than the other alarm calls sounded by the bird from time to time : MY 69 Oct. 23 : photograph MY 32). In an experiment tried, one chital was confused by an echo (TN 63 Apr. 2 : photograph TN 25). Alarms are communicated by chital themselves both visually and vocally—the raising of the tail in flight and the consequent exposure of the white ventral surface of the long tail is a flagrant visually communicated alarm : the shrill barkings of the deer, usually at the sight or suspicion of a leopard or tiger (TN 63 Apr. 4, Sep. 18 ; MP 68 May 13 ; MR 69 Nov. 18—it is seldom sounded when wild dogs are on the trail of chital—MP 69 Mar. 14) is an alarm well understood not only by other chital but also by other forest animals. The quick, repetitive stamping of the forefeet, though not a vocalisation, is also an alarm communicated by being heard (B 69 Feb. 25 : photograph B 18).

Perhaps the most remarkable intraspecific vocalisation of chital is the ' conversation ' that hinds indulge in when in cover. This does not appear to have been described, and so may be detailed here. Hinds speak to one another, usually in cover, in a low, bird-like, mewling voice ; these calls of chital hinds are richer in variety and better modulated than the mewling ' Chchaai ' of barasingha already described, as was specially noticeable when these calls of both the deer were heard together once, at the Kanha N.P. (MP 70 Mar. 21). Chital hinds were heard and observed indulging in these calls on several occasions and in different locations (TN 62 Mar. 19, TN 64 Apr. 4; MP 68 May 7; MY 68 Oct. 6, MY 68 Oct. 24 ; MP 70 Mar. 21).

A remarkable variant of this mewling call is when it is used (to borrow a convenient phrase from telephonic communication) as a ' particular person call ' and a warning call. This call is quite loud and longer than the conversational mewling, but is basically the same. Chital hinds were twice heard warning stags of our near approach on elephant back, though on both occasions the stags were aware of our proximity and unafraid (MP 70 Mar. 20 and 21).

Chital seem less dependent on smell than other deer, though the sense of smell is highly developed. They do not seem to be able to appreciate airborne scents when the wind, blowing towards them, is strong (TN 64 Sep. 30). Some hinds actually ate the follicles of a creeper (*Pergularia extensa*) draped over me, without being aware of me, but in the circumstances (the freshly broken creeper having a smell) perhaps this is not conclusive evidence of their poor scenting abilities (MISC 60 June 7). They are certainly able to scent a man when they cannot see him (TN 66 Sep. 17).

Being versatile feeders, what they eat is probably much more dependent on what is available than on decided dietetic preferences. They eat short grass (which seems to be the main fodder in open scrub and forest) steadily, grazing as they go along (MY 69 Oct. 14 : photographs MY 24, MY 34), when in a herd grazing in close formation ; while coarse tall grasses are not relished, thin grasses of medium height are also eaten (MY 69 Oct. 9 : photograph MY 21). Grazing is not always in bulk, and sometimes much time is spent in feeding choosily on minute ground vegetation (TN 62 Mar. 25). A number of herbs and shrubs are also eaten among them *Grewia aspera* and *G. hirsuta*, *Helicteres isora*, *Toddalia aculeata*, *Limonia alata*, *Pavetta indica*, *Indigofera* spp. and lantana (MY 69 Oct. 7 and 22). Tree foliage is also browsed (such as that of *Emblica* spp., often eaten while standing erect on the hind legs : MY

68 Oct. 8 : photograph MY 2), in bulk when short grass is not freely available. The fruits of *Toddalia aculeata* (TN 62 Sep. 25), *Aegle marmelos* (B 70 Feb. 26 : photograph B 35) and *Zizyphus xylopyrus* (the foliage is also relished), *Ficus glomerata* (MP 69 Mar. 10), *Randia dumetorum* and other forest fruits are freely eaten. The association between chital on the ground and langur up trees has often been noticed and commented on, but seems to be one where there is no mutual benefit, but purely a scrounging association (TN 62 Mar. 25 and MP 69 Mar. 10). The bulk of the feeding is done in the morning, from about 7 a.m. to 11 a.m., and in the afternoons : some feeding is also done at night. The main periods of rest depend, to some extent, on how much fodder has been available, for when well fed chital lie down to chew the cud : however, they are usually lying down early at night, late at night, early in the day before and after dawn (MY 69 Oct. 22 : photographs MY 28 and 29) at midday. At night the parties often assemble into herds.

Water is a prime necessity. Chital drink at night, and at many times during the day, but mainly in the morning, at noon and in the evening (MY 68 Oct. 8 and 11 : photographs MY 1 and MY 8 : B 69 Feb. 17, 21, 23 and 25) ; B 70 Feb. 22, 23, 24, 25 and 28 : photographs B 13 and B 33). They are usually very cautious in their approach to the water, and scout the ground ahead and on all sides before lowering their muzzles to the water : as a rule they slake their thirst quickly, drinking deeply and continuously, but a stag in velvet, was observed to drink for 6 minutes. As this is a report concerned mainly with ecology and not with behaviour, behaviouristic observations noted on the occasions listed above have not been abstracted in the field notes, but it was noticed that when approaching water apprehensively, particularly when no other animal was already drinking at it, young or subordinate animals were frequently forced into the lead with pointed looks and threat displays. Chital drink, even at small pools, freely along with other animals, such as gaur or peafowl (photograph B 17).

Cattle are frequently grazed in areas noted for their chital, as at Masinagudi and Bandipur, and cattle-borne diseases, such as rinderpest, may be communicated to the deer (MY 68 Oct. 15 and 24). It was noticed that a stag affected with rinderpest sought seclusion and cover, when very ill (MY 68 Oct. 10). Deaths from predation were also noticed (TN 66 Oct. 4; MP 70 Mar. 14).

THE MUNTJAC

Muntiacus muntjak (Zimmermann)

(Summary of field notes : Observation records: 37.

Locations: Kerala—Periyar Sa.; Tamil Nadu—Mudumalai Sa.; Mysore—Bandipur Sa.; Orissa—Raigoda Sa.; Usha Kothi Sa.; Bihar: Hazaribagh N.P., Palamau N.P., Kodarma; Madhya Pradesh—Churna, Bastar, Bara Naya Para; Maharashtra—Taroba N.P.

Photographs: TN 37*:* B 10*:* MR 9).

The muntjac was seen occasionally in most forests visited, and heard quite a few times. An excellent account of it is provided by Dunbar Brander.

Size : *Morphological characters*

Adult size differs with sex, and also with location. The male is about the size of the chowsingha, the female smaller. Colour also differs in the sexes, the male generally being a bright chestnut or a burnt sienna and the female paler and more fulvous. The canines in the upper jaw of the male are, as Dunbar Brander points out, formidable weapons, inflicting deep, gashed, wounds : these are not fixed rigidly in the jaw but are capable of some movement. I still carry a 3-inch scar on my leg from a deep gash inflicted by a zoo muntjac over 40 years ago, acquired when I was curious with regard to dentition and tried to have a closer look. Prater says that the young are spotted till about 6 months old. Two infant, hare-sized young seen with their mother and watched closely for a long time were whole-coloured, and showed no spots (TN 64 Apr. 11 : photograph TN 37).

Distribution

Within the peninsula the muntjac is confined to the hill forests, though their elevation, as at Periyar and Bandipur, may not be apparent at first sight.

Habits : *Behaviour*

The muntjac is usually solitary, though at times it may be seen in a pair, or an adult female with one or two young. (photograph B 10). As Dunbar Brander points out, it keeps more or less to the same forest area, its range.

Dunbar Brander comments on its stilted gait, the feet being raised and set down almost vertically, with a high-stepping, delicate action, as if treading on eggs. This action is not the normal gait of the animal, but adopted when it is conscious of being watched and at the same time not seeking instant escape by flight. An adult female which crossed the forest road ahead of our jeep moved with this exaggerated action, and I was impressed by the way the gait lent itself to a bounding getaway at once in any direction desired (MR 69 Nov. 17 : photograph MR 9). The normal response to men (even when in a jeep or on elephant back) is instant and precipitate flight (TN 64 Apr. 11 ; B 69 Feb. 15 ; K 70 Apr. 29, a.m. and p.m.). Even heavily gravid females tore away at top speed on sighting men on elephant back, jumping over bushes 3-foot high (TN 62 Mar. 23, 63 Apr. 1). The normal gait of a muntjac moving along the forest floor is an easy, slow walk.

Muntjac are choosy feeders. An adult female (the one with the 2 infants at heel) was watched for quite some time, and ate grass shoots and herbs selectively ; she lifted her head to an overhanging leafy twig (of *Zizyphus xylopyrus*), wrapped an astonishingly long tongue around the twig, and stripped the foliage off it by withdrawing the tongue into the mouth (TN 64 Apr. 11). Barking deer are very fond of the fruit of *Melia composita*, intensely bitter to the human taste (O 69 Jan. 16 and 18).

As Dunbar Brander points out, the sound as of castanets sometimes accompanying a muntjac's precipitate departure is purely vocal, merely the normal alarm call (always sounded standing) diminished in volume and broken up into staccato sounds by the rapidity of the movement ; I, too, have observed this from close quarters. Some muntjacs have hoarse, and some sharper voices.

THE INDIAN CHEVROTAIN

Tragulus meminna (Erxleben)

(Summary of field notes : Observation records: 9.
Locations : Tamil Nadu—Mudumalai Sa.; Orissa—Nawana (Simlipal hills).
Photograph : TN 34).

Unless one goes looking for it specially, on elephant back, the mouse deer is easily missed. One seen in the Kanha N.P. is not recorded in the field notes because all that was seen was an agitation of the undergrowth going away from the riding elephant with an occasional glimpse of a whitestreaked olive brown coat.

Size : Morphological characters

Prater gives the height at the shoulder at 10 to 13 inches, but gives no weight. An adult female weighed 12 lb.

Distribution

Prater gives the 24° latitude as the northern limit of the mouse deer in the peninsula. I have seen it almost commonly in Karwar and in some forests in south India.

Habits : *Behaviour*

Besides feeding on herbs and shrubs on the forest floor, mouse deer eat a number of fallen fruit, among them the fruits of *Terminalia bellerica, Gmelina arborea* (much liked by all deer) and *Garuga pinnata.*

When standing at ease, a forefoot or a hind foot is often trailed, as if lame in that leg (TN 64 Apr. 2). The gait is a trot when moving fast, or when walking a creep. A thickset male watched for some time panted open-mouthed like a dog, though without the tongue hanging out of the mouth (TN 64 Apr. 10). Mouse deer can climb up sloping tree boles and often go to earth in a hollow tree. They lie up in grass or even on the bare earth, like a hare in its form.

THE WILD PIG

Sus scrofa cristatus Wagner

(Summary of field notes : Observation records: 85.

Locations: Kerala—Periyar Sa. ; Tamil Nadu—Mudumalai Sa., Pt. Calimere Sa.: Mysore—Bandipur Sa.: Andhra Pradesh—Kawal Sa.; Orissa—Raigoda Sa., Usha Kothi Sa.; Bihar—Hazaribagh N.P.; Palamau N.P.: Madhya Pradesh—Kanha N. P., Shivpuri N.P., Churna ; Maharashtra—Taroba N.P.

Photographs : TN 46 : MY 6: MR 5, MR 11, MR 12 and MR 14; K 12, K 15, K 16 and K 20).

Except in the Periyar Sa. and Taroba N.P., pigs were not often seen, though their slots, and the ground they had dug up, bore testimony to their being there. Large sounders were seen in Kanha, Bandipur, Taroba and Periyar : only small parties in other places, though there seemed to be plenty in Shivpuri.

Size : *Morphological characters*

Apart from the boar being considerably larger than the sow (though some old sows are of impressive size), adult wild pig vary in size from place to place and even within the same area. Prater gives the height of a well-grown boar at 3 feet and its weight around 500 lb. Some big boars were seen, but not of that weight.

Distribution

All over the peninsula, in open forests. In forest-side areas, pigs are determined crop-raiders, and do substantial damage to groundnut, digging up an entire field overnight.

I thought the pig at Point Calimere Sa. probably feral and not truly wild. Since indigenous domesticated pig are probably descended directly from the wild animal, it would be difficult to distinguish between feral and wild pig—as in the buffalo, feral animals look very like their wild ancestors.

Dr. H. Khajuria of the Zoological Survey of India, consulted, informed me that on the basis of skins examined by him he could find no criterion for distinguishing between wild and domesticated pig by a morphological characteristic. The question is obviously one that will have to be decided by a taxonomist, but I still feel that the pig at Point Calimere are feral and not truly wild. There are no wild pig anywhere around this isolated coastal forest but there are domesticated pig in villages not too far away. Cattle and ponies have been allowed to run wild, and have run wild, here, and it could well be that a few village pig which had escaped to the Kodikadu Reserved Forest were the basis for the present population of ' wild pig ' : there are no predators here large enough to act as a check on the pig. The one possibly significant point I noticed about the pig at Point Calimere was that even on the largest boars the ridge of hair along the back from the nape, thick in wild pig and with only a slight backward slant when not erected, was noticeably thin and had a lean to one side (TN 68 Dec. 10, 69 Dec. 12 and 18). The subspecific distinction of *Sus scrofa scrofa* of Europe from *Sus scrofa cristatus* of India appears to be sustained in part by the thicker and more luxuriant dorsal ridge of bristles of the latter (photograph MR 5).

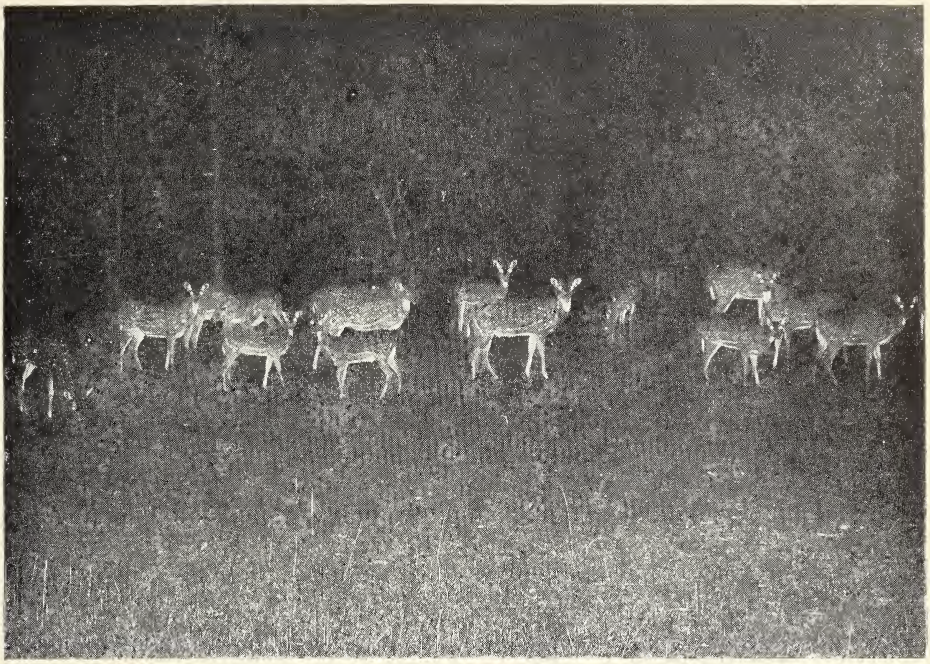
Habits : *Behaviour*

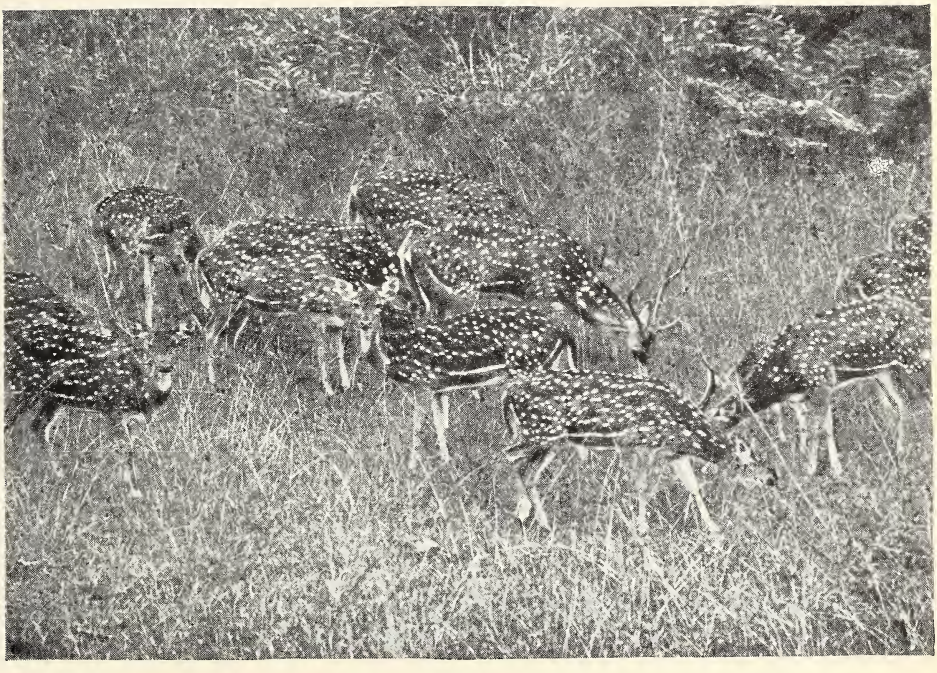
Wild pig seen by day were extremely fugitive, and bolted at the sight or scent of man (TN 59 Mar. 7 and 22, 63 Mar. 25 etc.). A lone boar met on foot by day was singularly reluctant to move away, even belligerent (TN 64 Sep. 17). Pig running away do not turn round for visual confirmation of a scent warning or to see if they are being followed : they change direction suddenly in flight, and take advantage of every dip and bit of cover to disappear from view.

In the thicker tree forests, no sounders were seen, but only pig in small parties and singly : large sounders were noticed where the ground was more open and there were clearings and maidans, at the Periyar Sa., the Bandipur Sa., the Kanha and Shivpuri N.Ps. and the Taroba N.P. (K 60 Apr. 18, K 70 Apr. 28 : photograph K 16, K 70 Apr. 29 : photograph K 20; MY 68 Oct. 10; MR 68 Nov. 15 and 16, MR 69 Nov. 20 : photograph MR 11, MR 69 Nov. 22 : photograph MR 12 : MP 70 Mar. 17 and 18).

In the Taroba N.P. cattle egrets followed the pig coming to the lakeside in the evening (MR 68 Nov. 17, 23 and 25). In the Periyar Sa. common mynas were seen accompanying the pig and riding on their backs (K 70 Apr. 27 : photograph K 15).

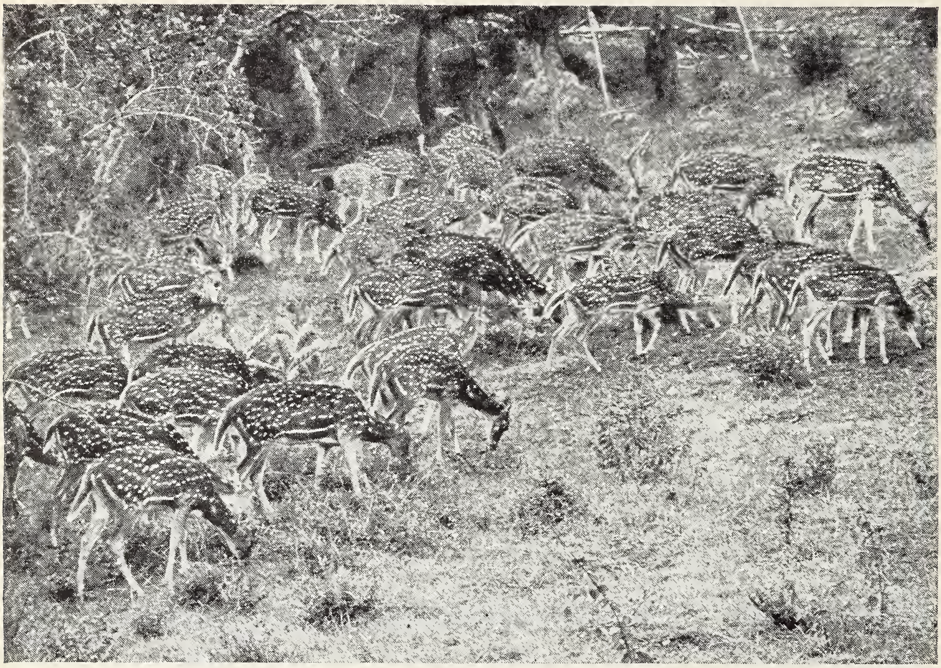
Pigs are very fond of wallowing, but differ from other animals that like to wallow (buffalo, elephant, sambar) in that they like some shallow water over the mire, and not merely mire, for this purpose. Once I saw a very big boar lying in 3-inch deep water in a puddle on a forest road, soon after heavy rain, rolling over and squirming about so violently that at first I thought the animal had been seized with a fit. Pigs were

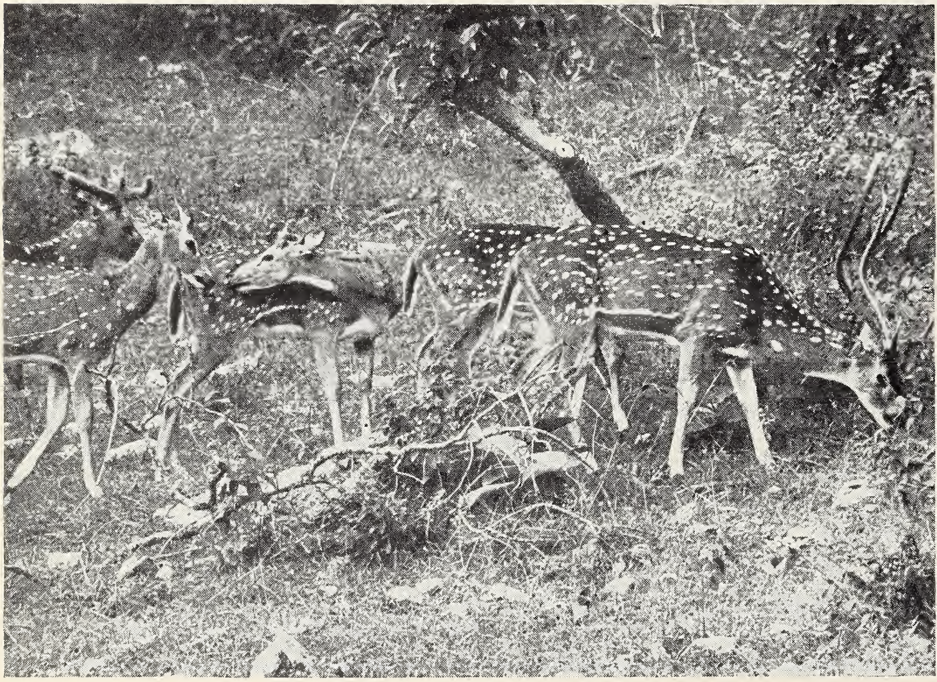




Above : MYSORE 1968 : BANDIPUR SA. : October 6 — 10 p.m. : Chital around the rest-house — MY. 20 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 9 — 5 p.m. : Chital grazing tall grass — MY. 21.

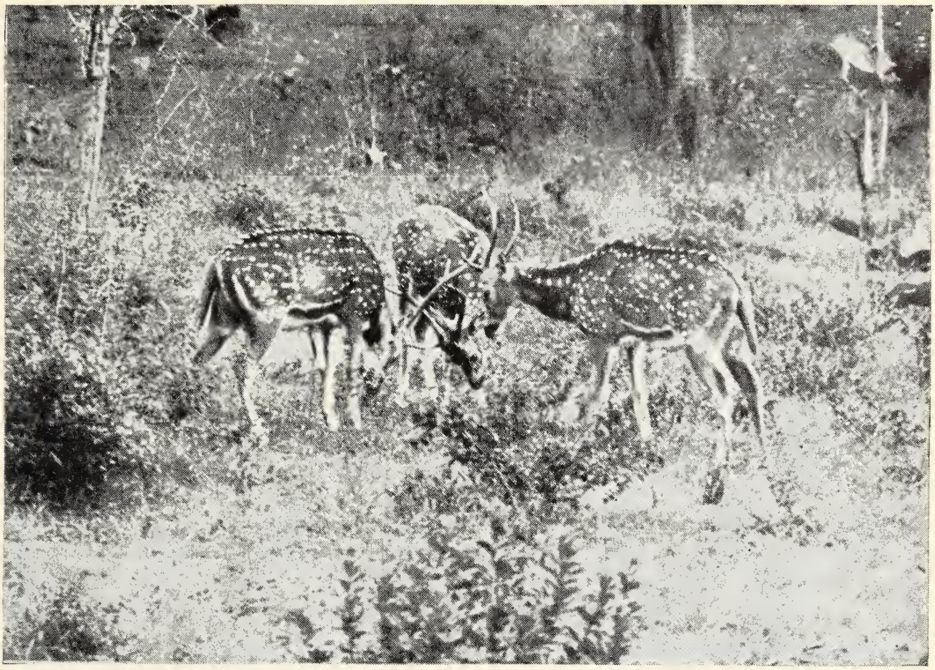
(*Photos : M. Krishnan*)

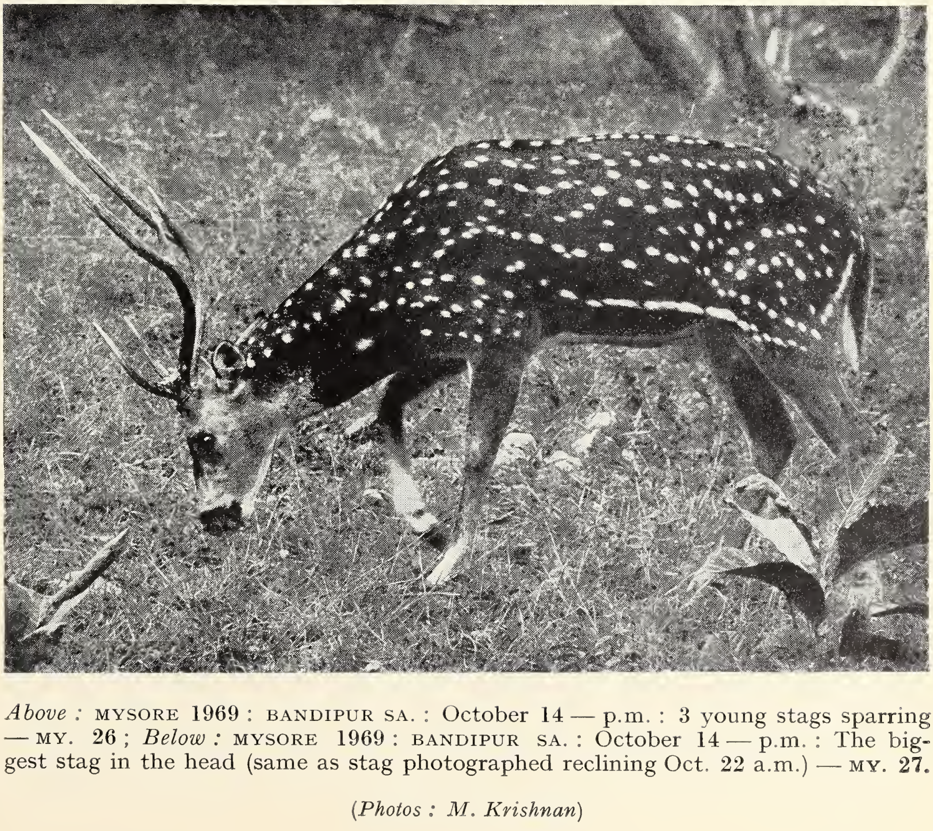




Above : MYSORE 1969 : BANDIPUR SA. : October 14 — 4.10 p.m. : Part of the herd crossing a clearing — MY. 24 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 14 — p.m. : A brocket biting at his flank. Note attitude of brocket just behind him — MY. 25.

(*Photos : M. Krishnan*)

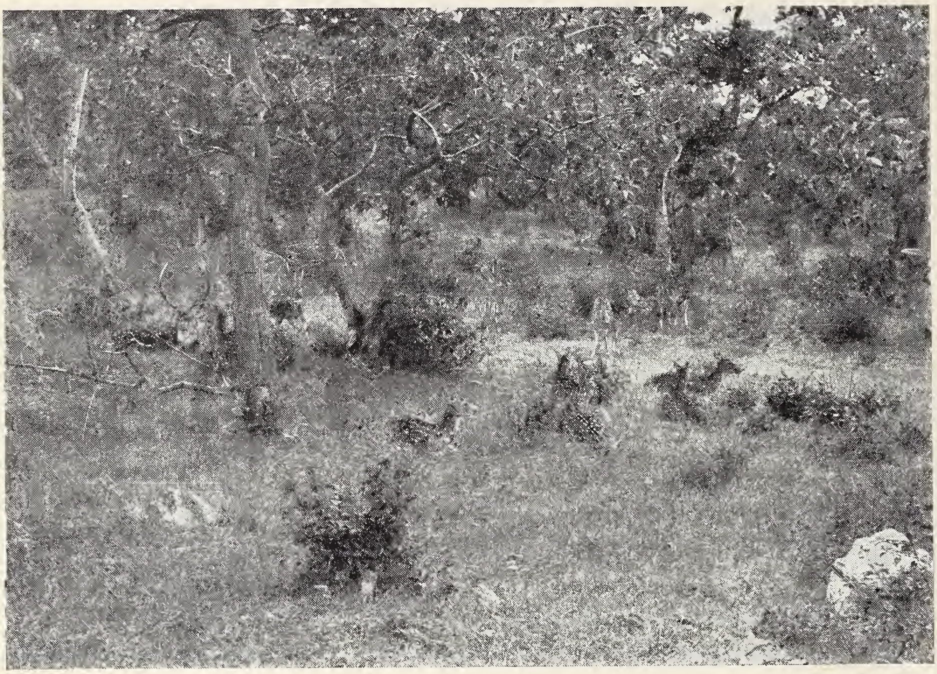


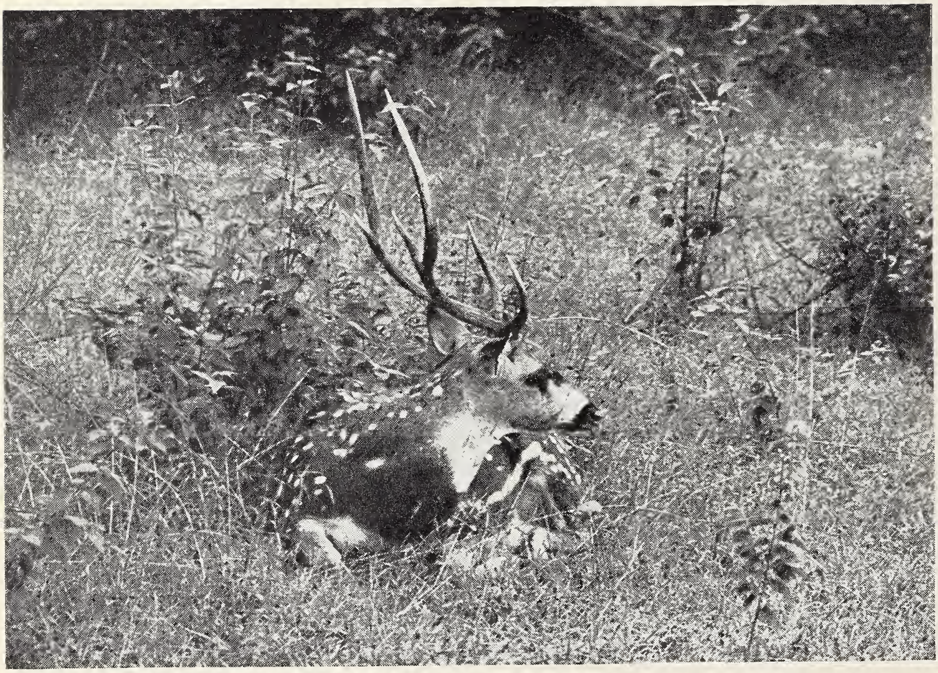


Above : MYSORE 1969 : BANDIPUR SA. : October 14 — p.m. : 3 young stags sparring — MY. 26 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 14 — p.m. : The biggest stag in the head (same as stag photographed reclining Oct. 22 a.m.) — **MY. 27.**

(*Photos : M. Krishnan*)

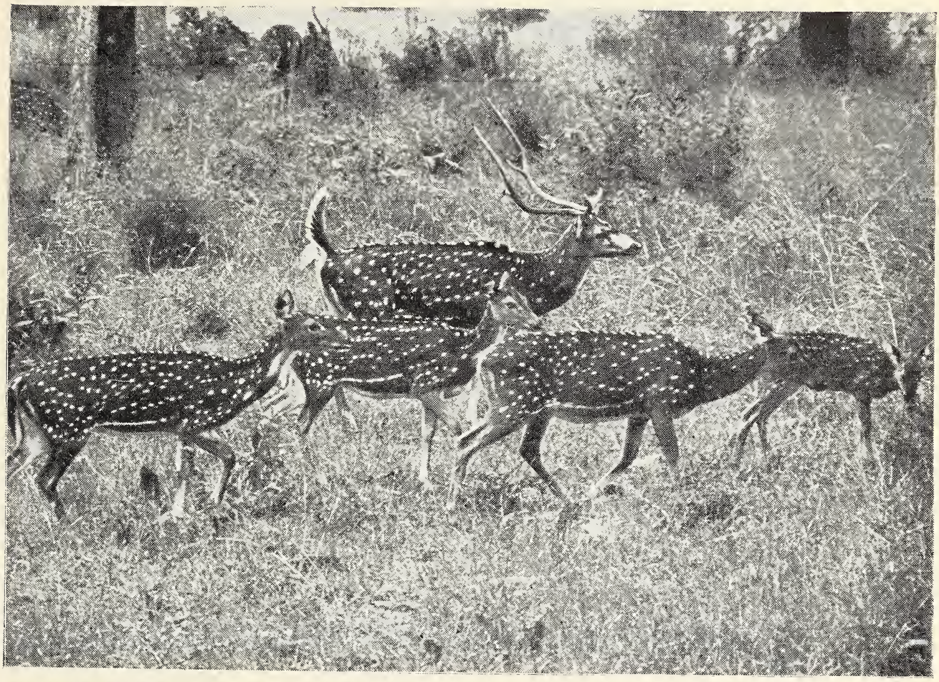
Krishnan : Mammals

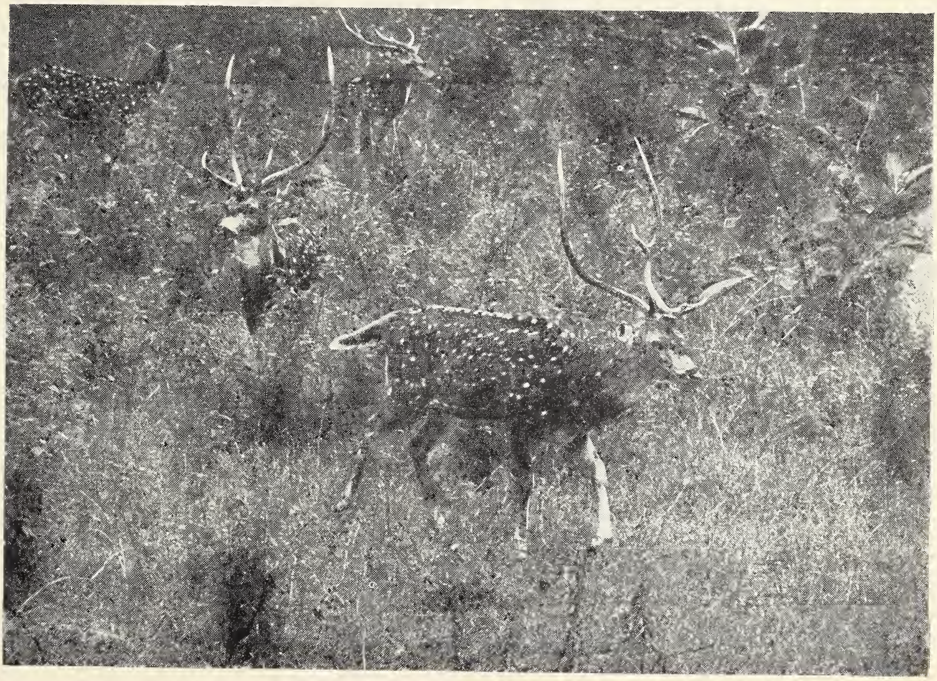




Above : MYSORE 1969 : BANDIPUR SA. : October 22 — 8.30 a.m. : Chital at rest — MY. 28 ; *Below* : MYSORE 1969 : BANDIPUR SA. : October 22 — a.m. : The big stag reclining (same stag photographed Oct. 14 — p.m.) — MY. 29.

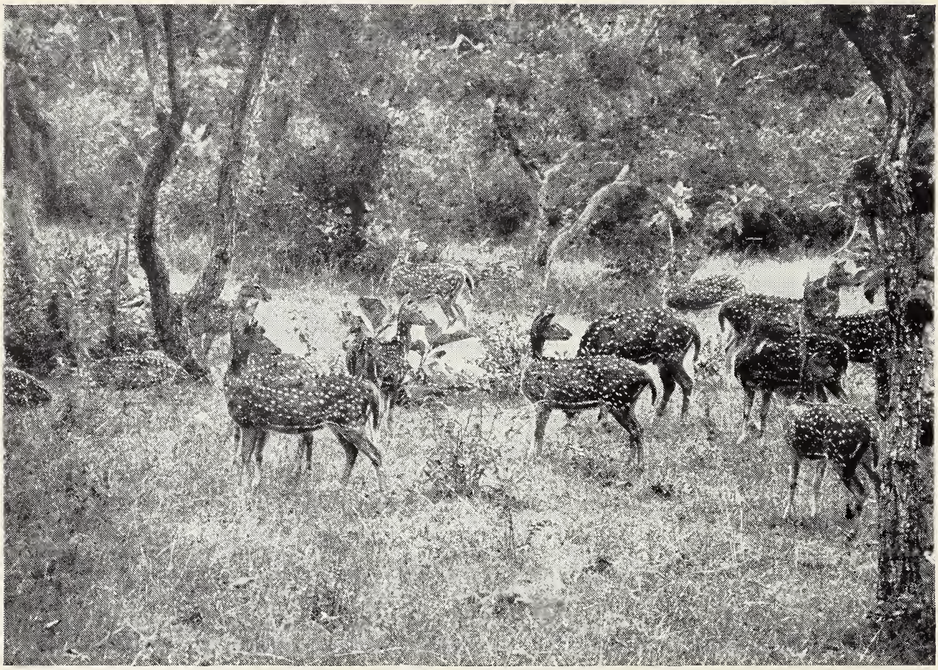
(*Photos : M. Krishnan*)

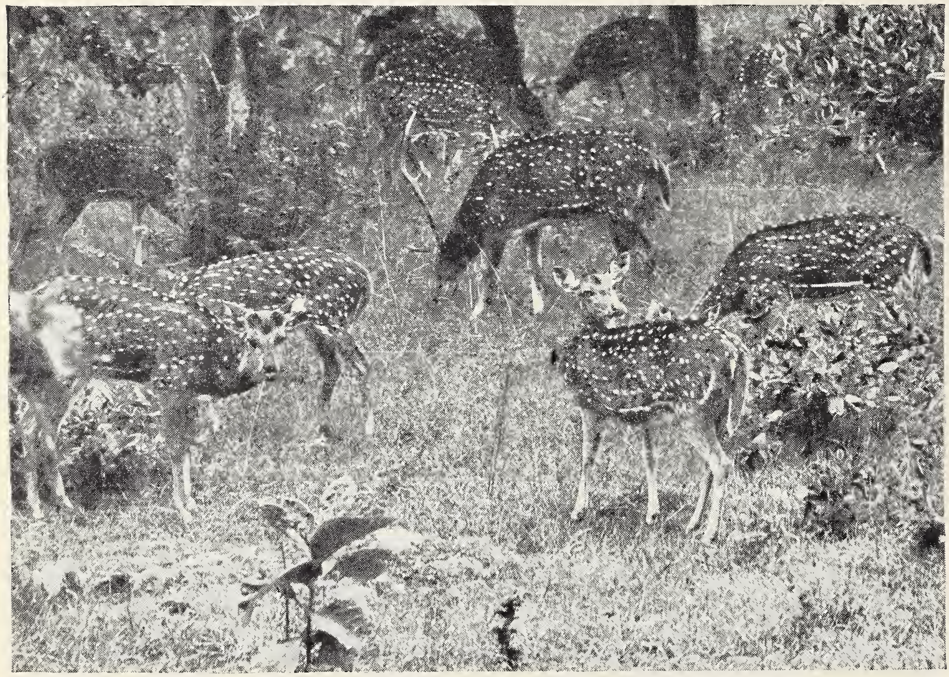




Above : MYSORE 1969 : BANDIPUR SA. : October 22 — a.m. : The light-coloured stag with short brow-tines — MY. 30 ; *Below :* MYSORE 1969 : BANDIPUR SA. : October 22 — a.m. : Short-brow-tine running from the big stag without any demonstration by the latter — MY. 31.

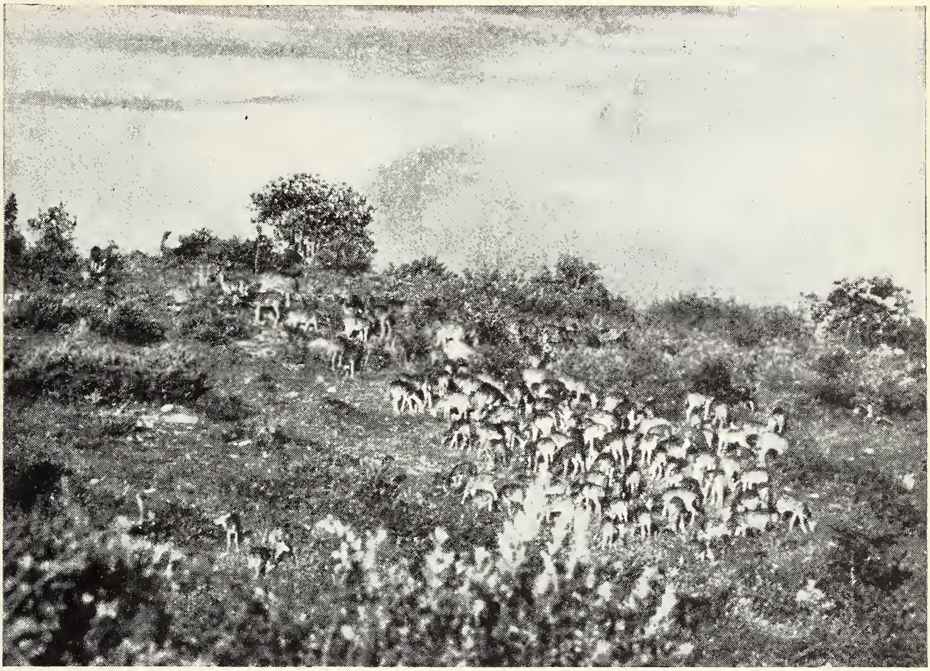
(*Photos : M. Krishnan*)

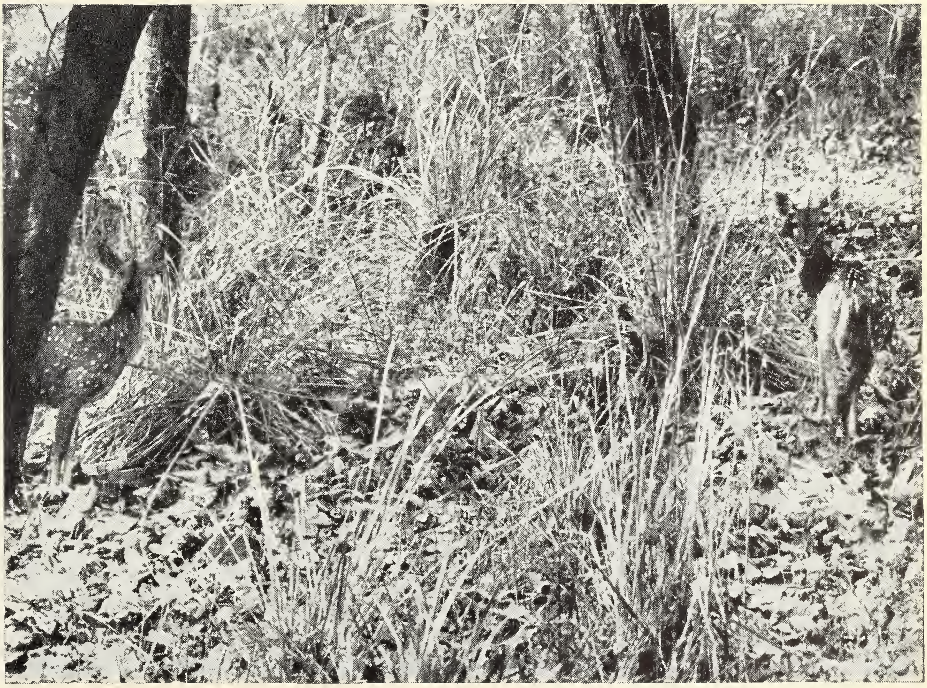




Above : mysore 1969 : bandipur sa. : October 23 — a.m. : Chital turning to look in direction of peacock's alarm call — my. 32 ; *Below :* mysore 1969 : bandipur sa.: October 23 — a.m. : Hind looking at me — my. 33.

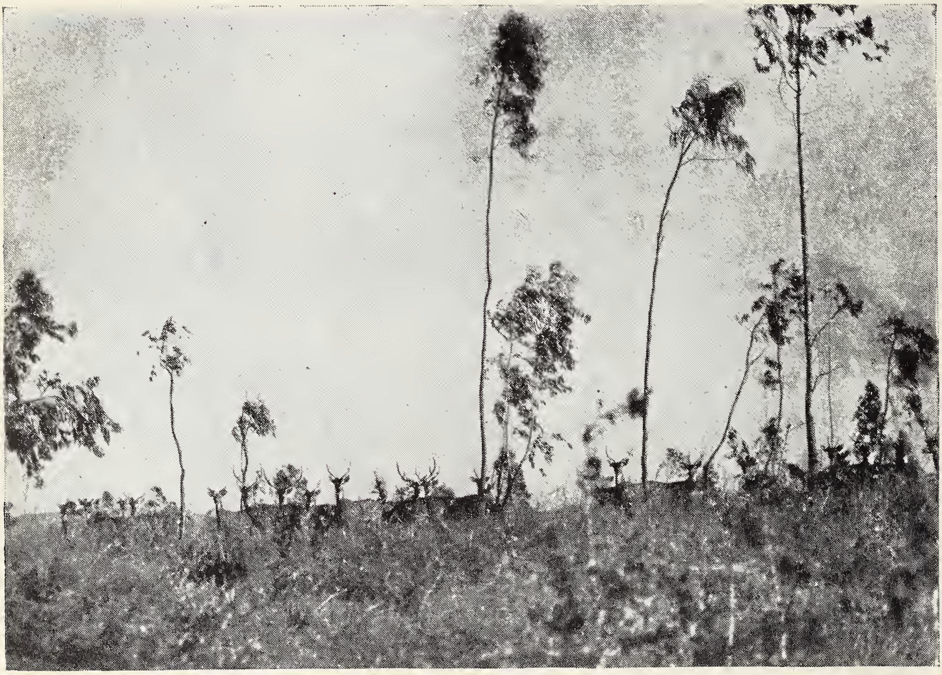
(*Photos : M. Krishnan*)

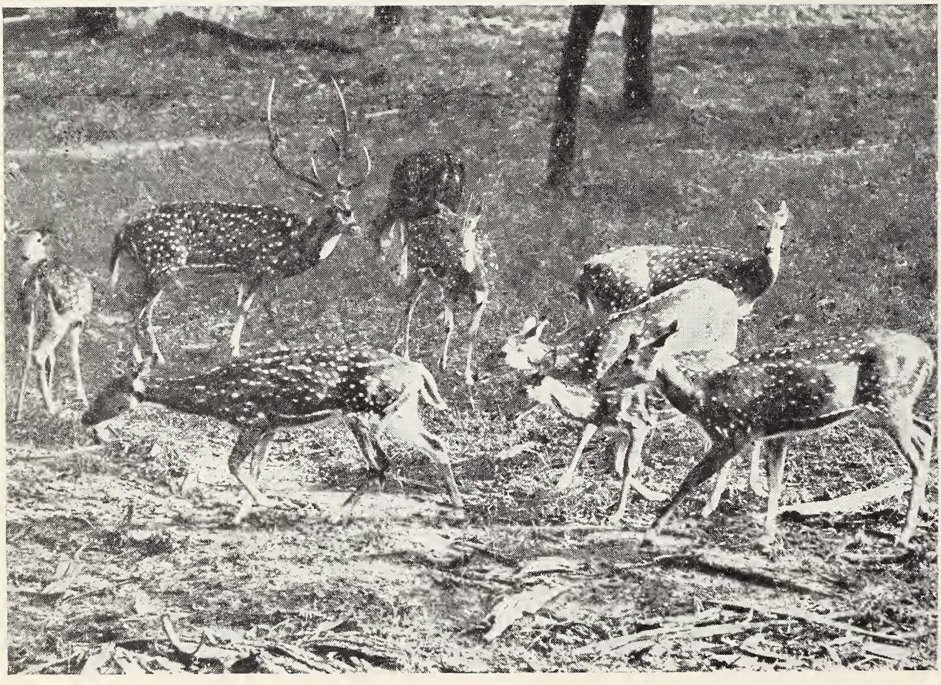




Above : TAMIL NADU 1962 : MUDUMALAI SA. : Masinagudi : September 23 — 6 p.m. : Chital on the hill — TN. 21 ; *Below :* TAMIL NADU 1963 : MUDUMALAI SA. : Kargudi : April 2 — a.m. : Pair of Chital hinds reacting to a whistle and its echo — TN. 25.

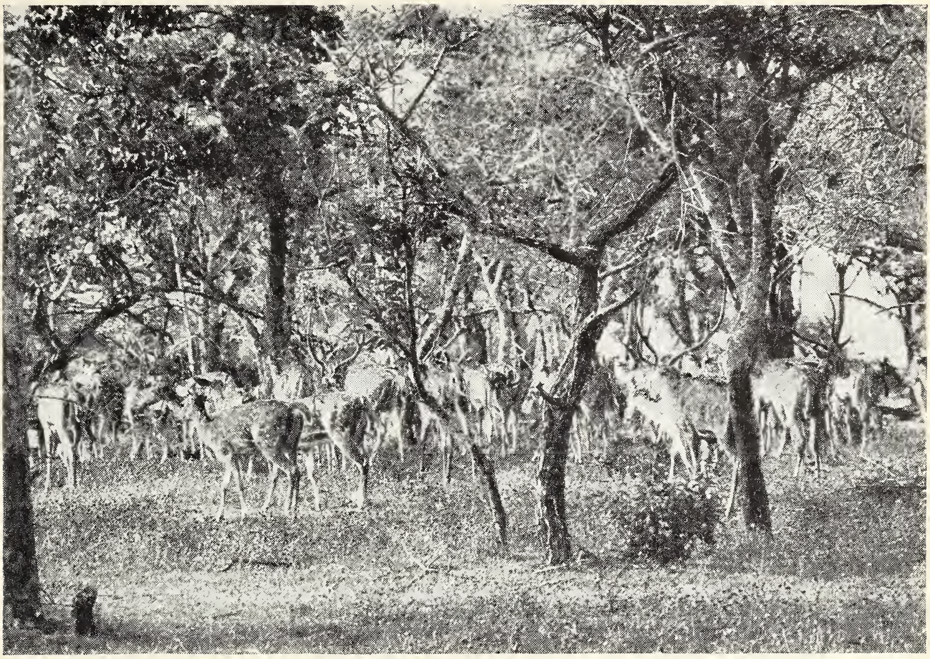
(*Photos : M. Krishnan*)





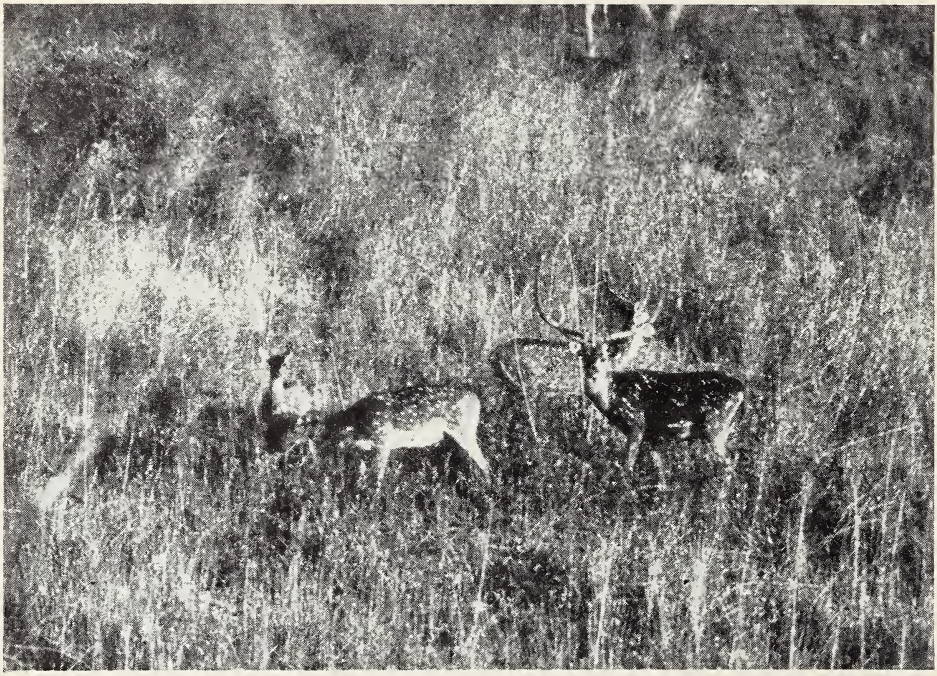
Above : TAMIL NADU 1964 : MUDUMALAI SA. : Masinagudi : October 4 — 6 a.m. : Stag-party of chital in the plantation — TN. 41 ; *Below :* TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : October 6 — p.m. : The party of chital in the timber yard ; stag following hind — TN. 42.

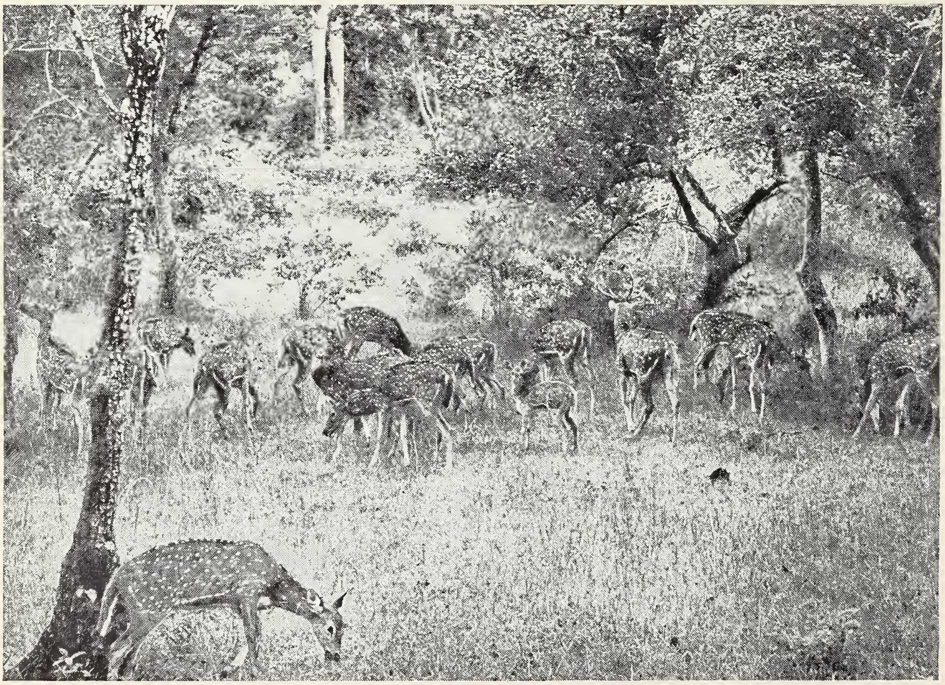
(*Photos : M. Krishnan*)



Above : TAMIL NADU 1969 : MUDUMALAI SA. : Masinagudi : October 3 — 5 p.m. : Chital in the open forest : Jeyadev Ave. — TN. 54 ; *Below :* TAMIL NADU 1969 : MUDUMALAI SA. : Masinagudi : October 4 — p.m. : Chital bolting from wild dogs — TN. 55.

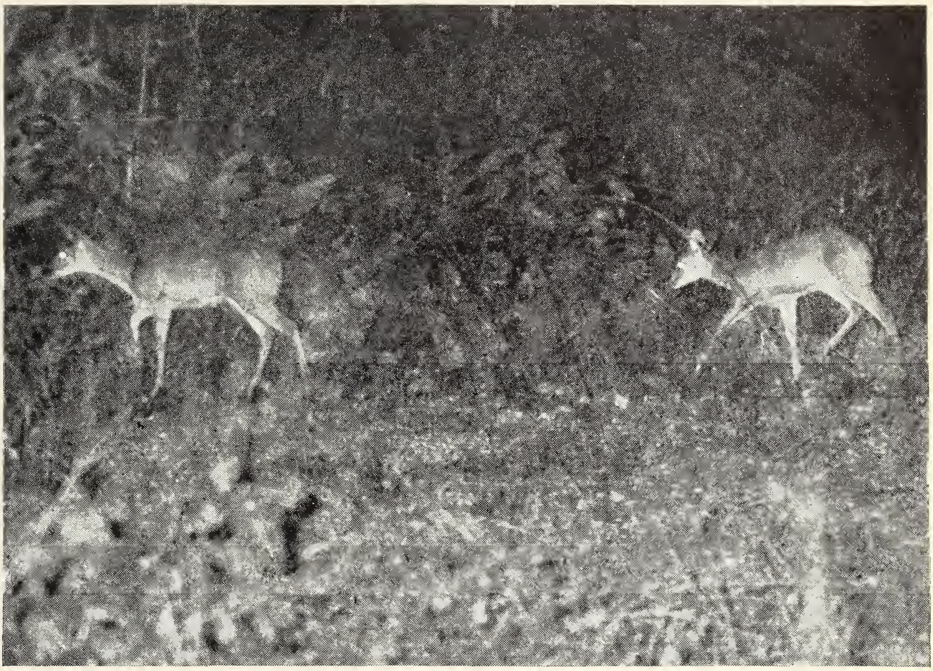
(*Photos : M. Krishnan*)

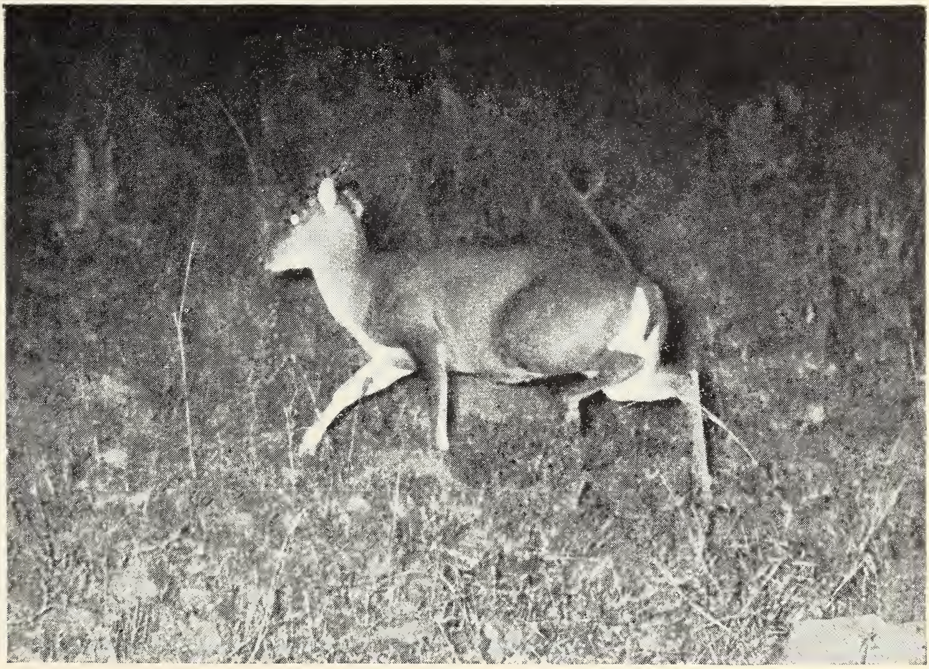




Above : M.P. 1968 : KANHA N.P. : May 6 — a.m. : Chital stag with widely divergent antlers — M.P. 6 ; *Below :* MYSORE 1969 : BANDIPUR SA. October 24 — about noon : Part of a Chital herd — MY. 34.

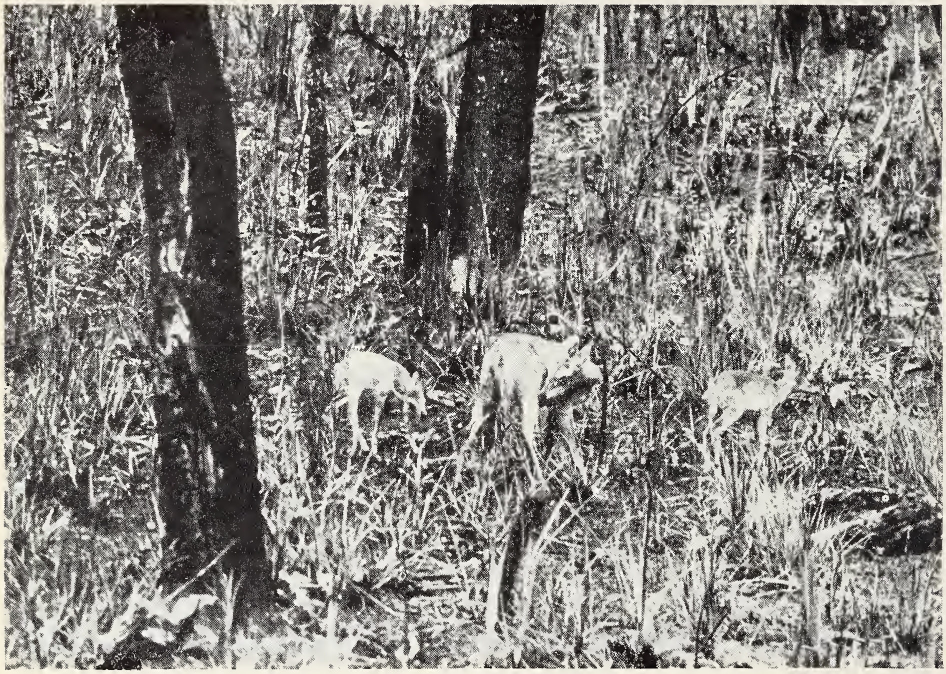
(*Photos : M. Krishnan*)

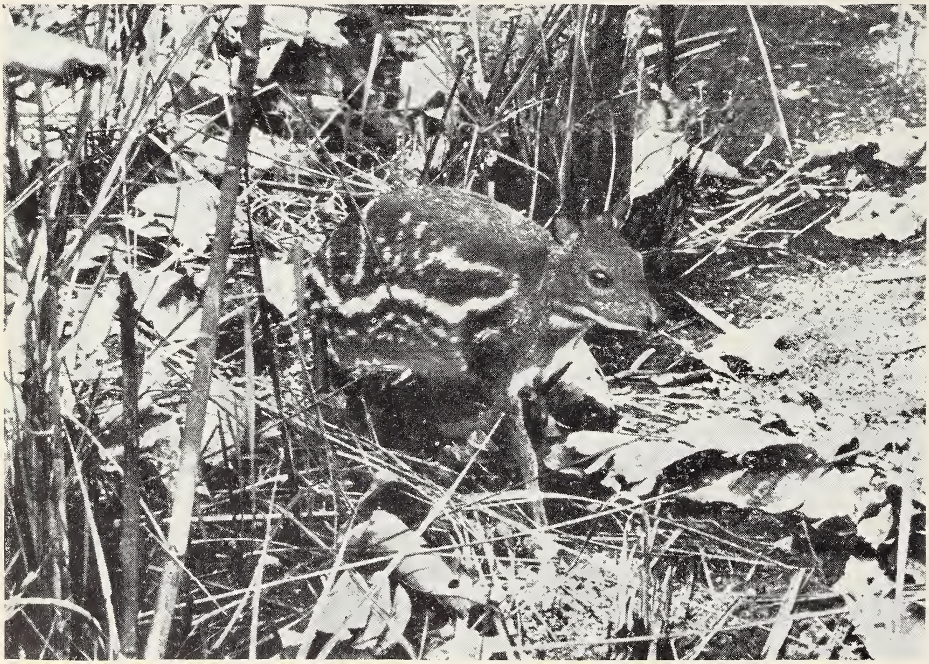




Above : BIHAR 1969 : HAZARIBAGH N.P. : February 15 — 8.30 p.m. : Female muntjac and young — B. 10 ; *Below :* MAHARASHTRA 1969 : TAROBA N.P. : November 17 — 11 p.m. : Muntjac crossing the road — MR. 9.

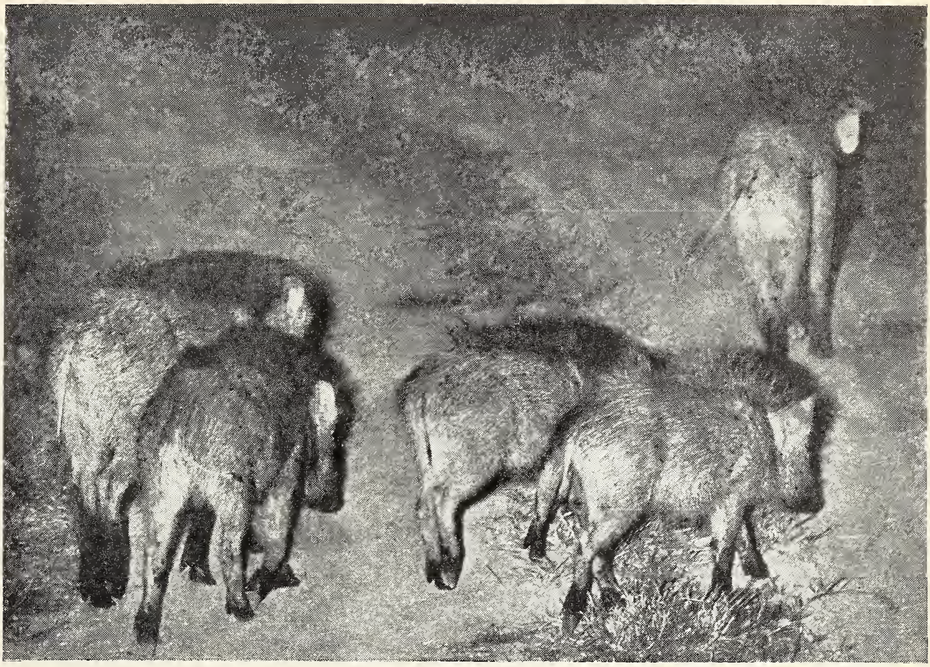
(*Photos : M. Krishnan*)

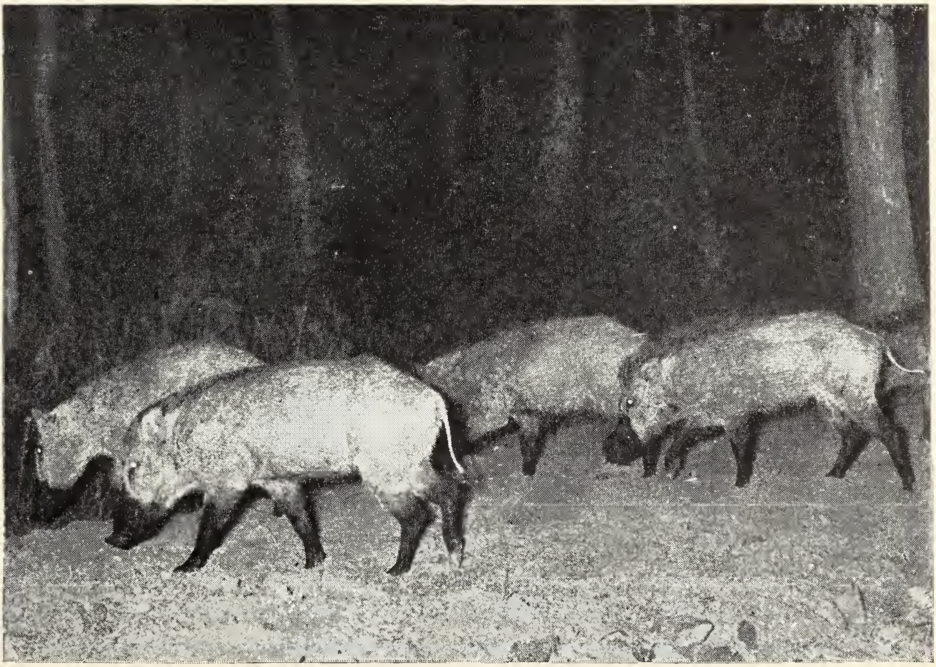




Above : TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : April 1 — a.m. : Female muntjac with 2 young — TN. 37 ; *Below* : TAMIL NADU 1964 : MUDUMALAI SA. : Kargudi : April 2 — p.m. : Female mouse deer — TN. 34.

(*Photos : M. Krishnan*)

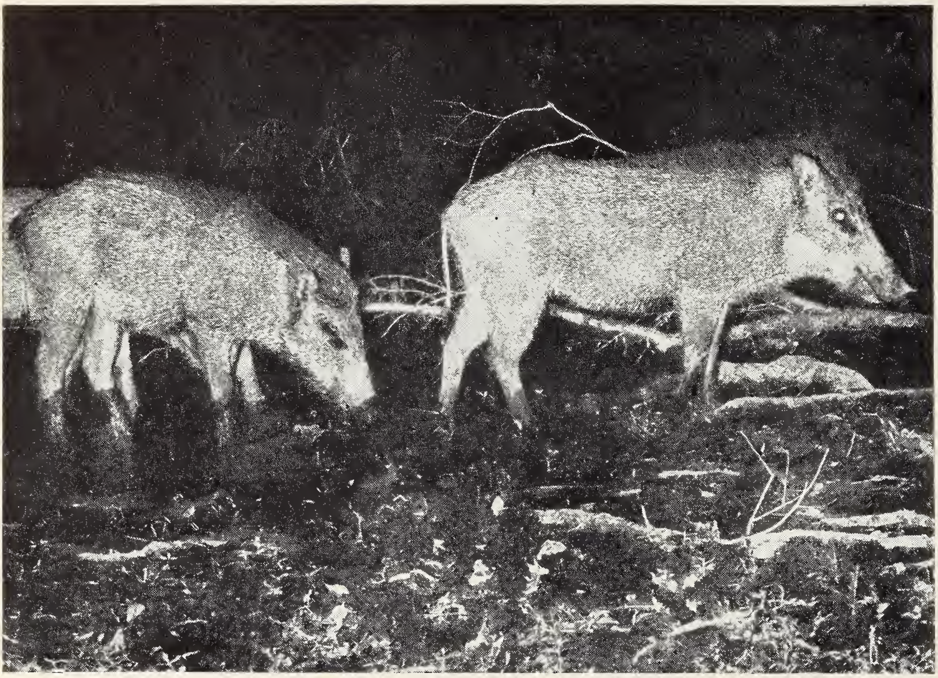


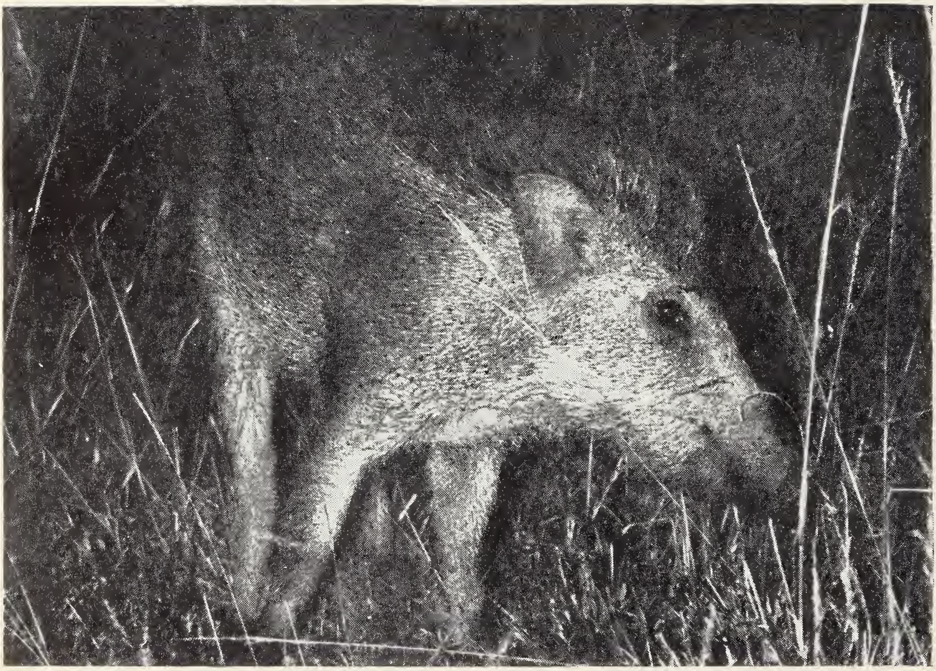


Above : MAHARASHTRA 1968 : TAROBA N.P. : November 23 — about 6.30 p.m. : Pig crossing the road. Note ridge of hair along back and thick limbs — MR. 5 ; *Below :* MAHARASHTRA 1969 : TAROBA N.P. : November 20 — about 8.30 p.m. : Pig at the roadside, near lake — MR. 11.

(*Photos : M. Krishnan*)

Krishnan : Mammals

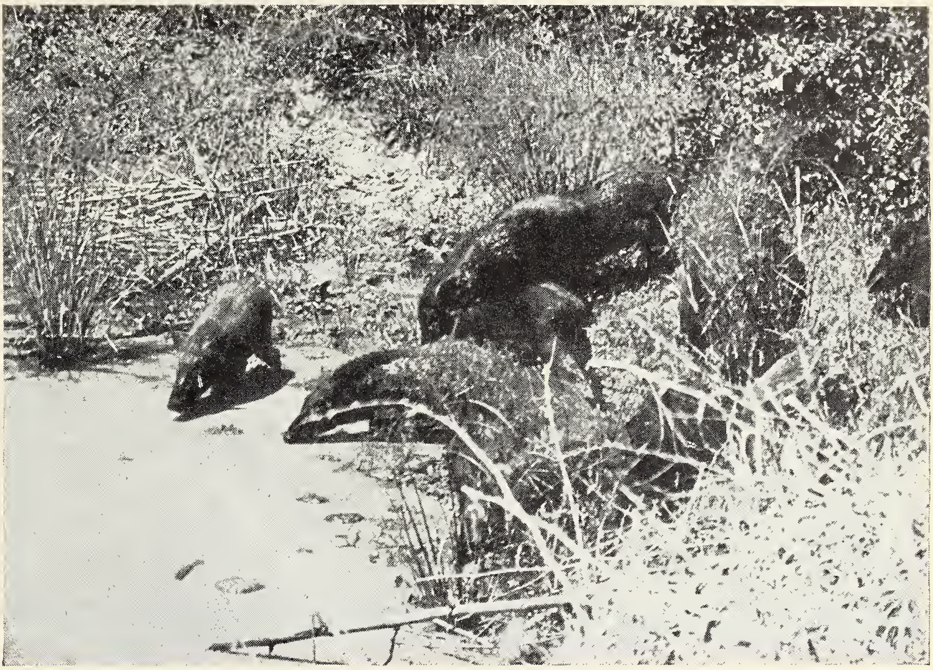


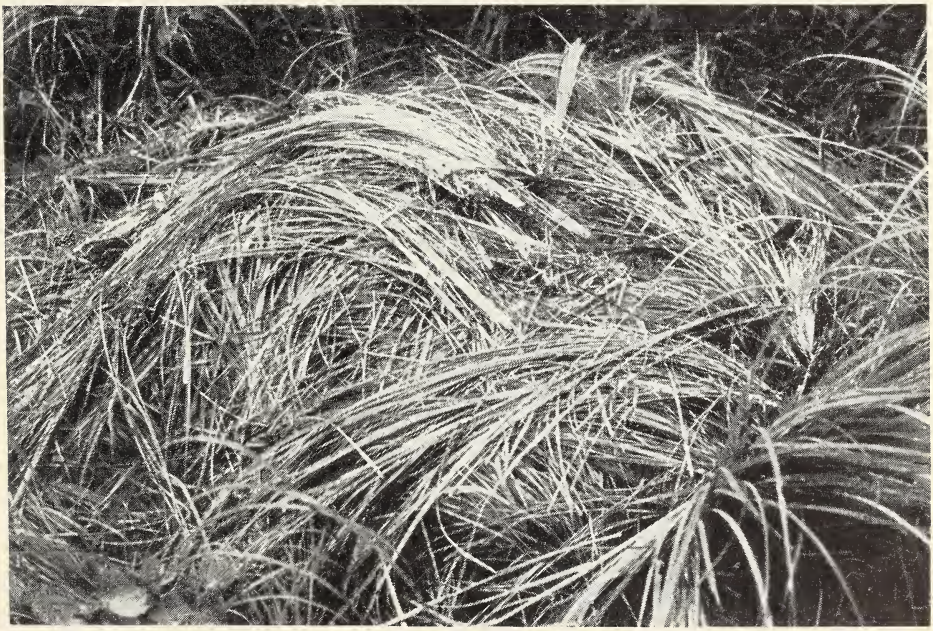


Above : MAHARASHTRA 1969 : TAROBA N.P. : November 22 — about 7.30 p.m. : Pig at the lakeside — MR. 12 ; *Below :* MAHARASHTRA 1969 : TAROBA N.P. : November 23 — about 8 p.m. : Close-up of a big sow — MR. 14.

(*Photos : M. Krishnan*)

Krishnan : Mammals

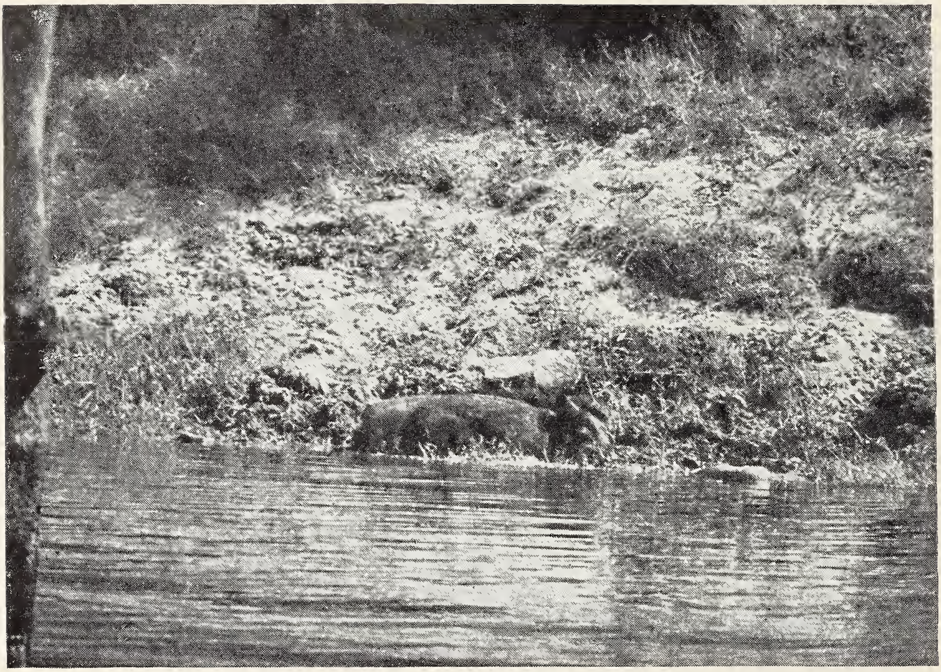


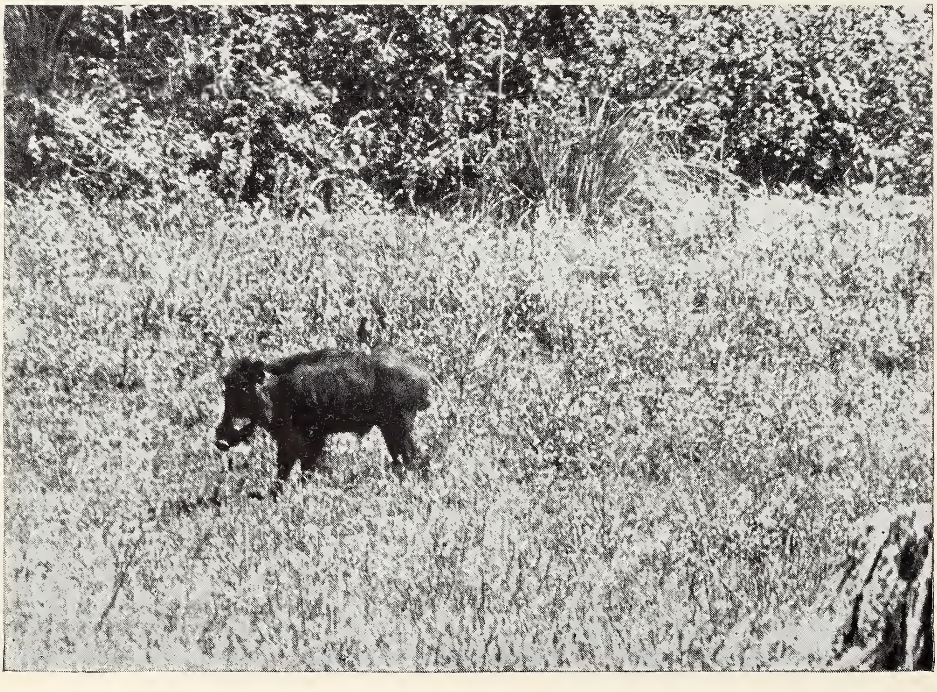


Above : MYSORE 1968 : BANDIPUR SA. : October 10 — a.m. : Pig drinking at Kollakumalikatté — MY. 6 ; *Below :* TAMIL NADU 1966 : MUDUMALAI SA. : Kargudi : September 23 — p.m. : Pig's nest — TN. 46.

(*Photos : M. Krishnan*)

Krishnan : Mammals

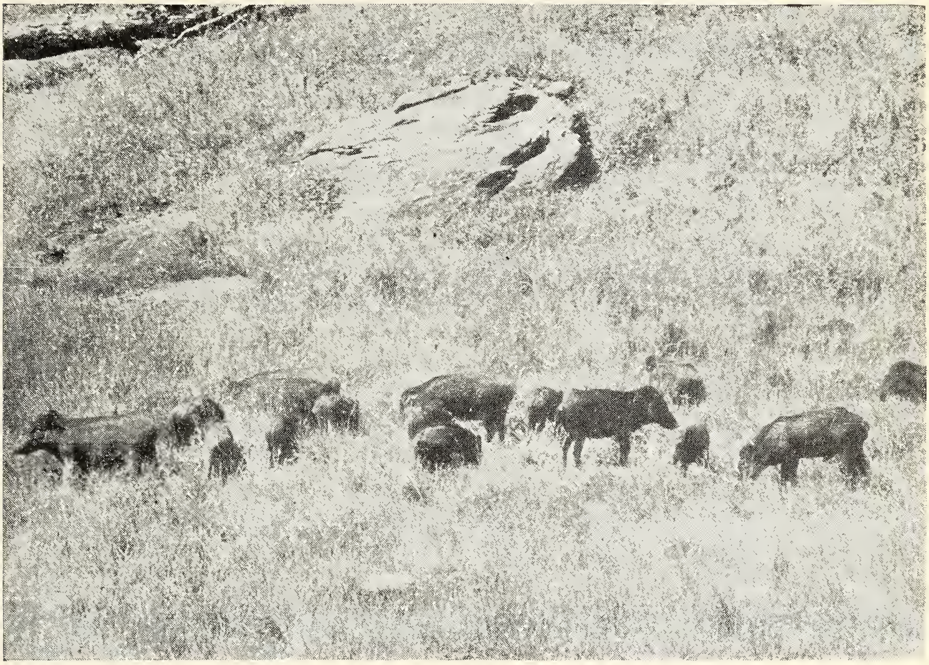


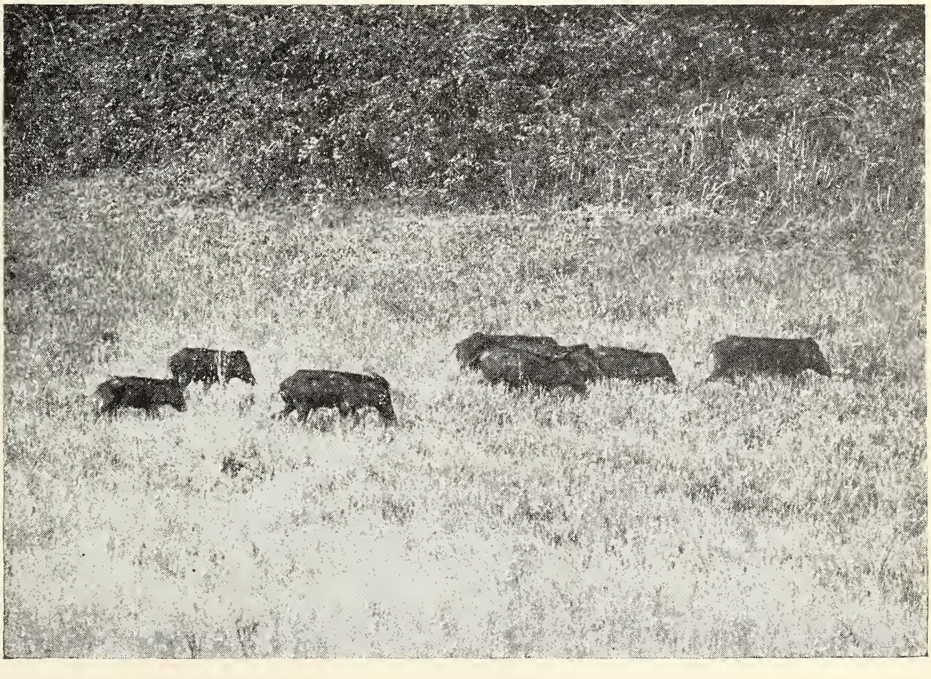


Above : KERALA 1970 : PERIYAR SA. : April 22 — p.m. : Lone boar wallowing at the water's edge — K. 12 ; *Below :* KERALA 1970 : PERIYAR SA. : April 27 — a.m. : Boar, with attendant myna — K. 15.

(*Photos : M. Krishnan*)

Krishnan : Mammals





Above : KERALA 1970 : PERIYAR SA. : April 28 — a.m. : Part of a sounder of over 30 pigs — K. 16 ; *Below :* KERALA 1970 : PERIYAR SA. : April 29 — p.m. : A line of pigs on the move — K. 20.

(*Photos : M. Krishnan*)

observed wallowing in shallow, miry water on a few occasions (TN 66 Apr. 25; MY 68 Oct. 10; K 70 Apr. 22 : photograph K 12). They rub their sides and hindquarters well into the mire to get them scrubbed, with squirming and rolling movements.

They were seen drinking at midday, in the afternoon, and late in the evening (MY 68 Oct. 10: photograph MY 6; MP 69 Mar. 23; B 70 Feb. 8, 9 and 12).

At Point Calimere I was assured that the local pig hunted crabs at night along the wave-line, and ate stranded fish. In the Taroba N.P. I saw them hunting some active, live prey, but could not identify it—perhaps they were hunting frogs or insects in that soggy grass. No doubt they do eat a variety of animal prey, and carrion, but the bulk of their food is vegetarian and much of it the underground stolons, rhizomes, corms and bulbs of plants.

It is astonishing the way pig can dig up the ground with their nose. A groundnut field visited overnight by pig, looks as if it had been freshly ploughed up, but it is not only soft, agricultural soil that their snouts can dig up. In Point Calimere and in the Masinagudi area of the Mudumalai Sa., I saw hard-packed ground covered with grasses and herbs, criss crossed with deep-ploughed lines where the pig had been feeding on the underground parts of *Cyperus* spp. and other plants (TN 68 Dec. 10). They eat tender tall grass and root for the stolons and rhizomes of sedges and grasses (K 70 Apr. 23, 28 and 29; MR 68 Nov. 23, 69 Nov. 22 and 23). A lone boar was observed eating puff-balls (TN 66 Apr. 25) and no doubt they eat other fungi as well—in Europe, domestic pig are used to locate truffles. The fine scent perception of wild pig enable them to locate buried food, and their cartilage reinforced snouts to dig it up.

Smell is the prime sense (TN 66 Apr. 25). Sight and hearing are only fair, but pig are well able to make out moving objects from a distance. When suddenly warned of danger by smell or otherwise, the erectile ridge of hair from the forehead to the hindquarters bristles and stands up suddenly.

Sows build regular nests of tall grass for their accouchement, and in the Mudumalai Sa. in September I saw and heard a sow actually building such a nest, and also some old, abandoned nests in the neighbourhood (TN 66 Sep. 21 : photograph TN 46).

In spite of their mass and extraordinarily thickset build, pigs are agile and capable of considerable speed. A very big boar was seen near Jamni village in the Taroba N.P., which leaped easily over a bush, 3-foot high by subsequent measurement (MR 69 Nov. 27). On the same occasion, 5 big pigs were seen lying up in the water of a nullah : it was very cold and late at night, and it was extremely likely that the water was less cold than the air.

Butterflies of New Delhi (Papilionoidea)

BY

ROGER ASHTON

Few would premeditatedly select New Delhi for representative collecting of Indian butterflies, but it is the very paucity of species that makes possible, for the part time collector confined to Delhi, a collecting coverage very difficult in richer areas. From the point of view of representative coverage over the period of a few years, New Delhi is an ideal locality in several respects. Large series of a limited number of species may be assiduously amassed. The condition of much of New Delhi being a gardened island of greenery in a very extensive semidesert region permits an easy and discrete study of sublocalities. Extremes of climate against relative abundance and migratory patterns afford highly informative correlations. The pattern and even incidence of the monsoon and other climatic events in Delhi are notoriously undependable and variable, and while this clearly relates to abundance of most species it must also affect the direction and scale of migrations. Certain species are so common at times in New Delhi that individual and seasonal variation can be satisfactorily covered in a relatively brief period. My time has permitted only a brief collecting coverage, and it is for this reason that my remarks below are intended by way of supplement to the study by Julian P Donahue that appeared in Vol. **63**, no. 2 and Vol. **64**, no. 1 of this *Journal.*

LOCALITIES

Contained by Rouse Avenue, Turkman Road, Circular Road, and Mathura Road, is what I describe as the Bharatiya Kala Kendra area, especially as the garden of Bharatiya Kala Kendra was the focal point from which my 1963 interactivity collecting radiated outwards. Bharatiya Kala Kendra was then at 2 Mata Sundri Road, at the very edge of the area habitable by Lepidoptera. North of B K K are situated Chitli Kabar, Sui Walan, etc., subdivisions of the crowded and plantless 'Shahjahanabad'. The Bharatiya Kala Kendra area consists of small gardens, empty plots, and even an enclave of the thornbushes and thorn-trees characteristic of the Ridge scrub jungle. All four species of *Colotis* and both species of *Ixias* recorded from Delhi were found there. Divided by lanes and small roads, the area is typical of most of effectually suburban New Delhi, and almost every species of the region may be collected there. My records partly exemplify this. Areas of this kind seem to harbour more *Portulaca oleracea* than the wilds, and so the *Hypolimnas* species are commonly seen in the gardens. This is also true of Bombay, where the plant is one of the first to utilise bare lots.

Very close to the foregoing sublocality there is a small plant nursery, located next to the Supreme Court and opposite Tilak Bridge. Near some relatively wild land, the garden contained a large patch of *Gomphrena globosa*, an everlasting flower much liked by *Danaus, Euploea, Hypolimnas, Precis, Tarucus, Syntarucus, Euchrysops, Lampides, Catochrysops, Catopsilia*, etc. *Vanessa cardui*, however, seemed to prefer a type of Michaelmas Daisy.

A large cut of both dense and relatively bare scrub and thorn jungle behind the Lakshminarayan Birla Mandir is essentially similar to parts of the Ridge Road Jungle further south. I employed six localities within the land contained by Shankar Road, Willingdon Crescent, Sardar Patel Marg, and Ridge Road. Part of it has long been Talkatora Gardens, into which some scrub species penetrate. The flower nursery in Talkatora Gardens was richer at times than other places in *Danaus limniace* and *Genutia*. To the west the gardens merge into jungle amid some ruins, whereas white Lantana makes collecting of *Colotis, Ixias, Terias* easy and fruitful. Through the gardens and down past the Riding Ground runs a filthy nullah that I call 'the nullah'. Shade and wildflowers made this disagreeable place excellent for collecting in late October and early November. Satyrids, Lycaenids, and Pierids not observed elsewhere were collected here. Immediately north of Malcha Marg there is a moderately wooded low-lying area in which white Lantana abounds, and on which migratory Pierids such as *Appias libythea* were seen in fair numbers in late October. The highest part of the Ridge, bordering on Ridge Road and halfway between Shankar Road and Sardar Patel Marg, is being gradually converted into Buddha Jayanti Park, where the large scale planting of Acanthids probably accounts for the abundance of *Precis* and of *Atella phalantha*. While being focal for species scattered over the surrounding scrub, the park attracts few *Colotis* or *Ixias*. The upper part of the Ridge traversed by the path from the park to Talkatora Gardens was found of least utility in my collecting.

The 'Government Sunder Nursery' area between Sunder Nagar and Humayun's Tomb also consists of six sublocalities, each in some way particular to and useful for concentrations of different species. The differences and relative importance of these sublocalities of course vary from week to week, as is the similar case with the Ridge Road Jungle. Relevant here are two portions of the garden proper, a

G. globosa patch and environs in the SE corner, and a lane bordered by pink Lantana along the eastern edge to the NE corner, whereat there is a small enclave of thorn and other trees. Eastwards from the lane runs a path that passes through pink Lantana hedges, Papaya plants, trees, and thence to a thorn-tree shaded scoutground, after which there is the northern wall of the enclosure actually containing Humayun's Tomb. The scoutground and beyond to the wall is not relevant here. On and south of the path there are a few trees but mainly there is a great deal of pink Lantana. North of the path there is more pink Lantana on the edge of and in a slight dip among a few trees. For some reason this dip was a congregating spot for *Danaus genutia*, and the Lantana at the edge of the dip was where all but one of *Parides aristolochiae* in 1966 were seen. The slope downward north of the path continued down to a wasteland of tall grasses that Donahue has discussed and shown in a photograph with the first part of his study in this journal. The very northernmost last few yards of the slope into this wasteland contain white Lantana on which *Colotis*, *Ixias*, and *Cepora* congregate to a greater extent than elsewhere in the area. South of the path is far more a place for *Precis*, *Catopsilia*, as usual. The subdivisions of this small slice of land were constantly marked in my collecting. I found *Ypthima* for example most abundant south of the path near the Papaya plants, being there more common even than in the nullah.

Last, the square enclosure containing Humayun's Tomb provided three fruitful areas at different times. On the east side starts the bare land bordering the Jamuna, and to the north a small area of scrub jungle east of the sublocalities described for the Nursery. A fair amount of pink Lantana grows in the SE corner. There is a shrub-thicket that includes Chandni, a form of Oleander and probably the source of attraction for the *Euploea core* seen abundantly there in 1966. This was also the only sublocality where *Virachola isocrates* and *Rapala melampus* were seen, barring the latter caught in the nullah.

MATERIAL

All species described herein are detailed in the study by Donahue, which also contains discussion of classification into which I do not presume to enter. Most of my 1963-1965 collection was lost and jettisoned due to poor upkeep, but some key specimens have been presented to the Bombay Natural History Society. Some tagdata was lost with the improperly maintained collection. Collection conducted from summer 1966 onwards was papered and stored, so data is recalled, because until setting no exact correlation is possible. I devised a new system of storage that partly circumvents the latter difficulty.

Packed specimens that cannot safely be resurrected until the time of setting are separately inventorised with all data.

NOTES ON SPECIES

Previously Undocumented Rarities.

Donahue predicted the incidence at Delhi of species that were not earlier recorded. I document four of these :—

Precis atlites—A damaged specimen was caught in late September in the Nursery dip described, and another in good condition was seen on the pink Lantana in the Humayun's Tomb SE corner. The latter was of the northern race, unmistakably, and was seen in early October. It may be noted the 1966 monsoon was curtailed and had petered out at this time.

Telchinia (Acraea) violae—Specimen presented to the Bombay Natural History Society was caught in good condition on the morning 12-iii-64 on an open brick and dirt wasteland next to a school compound, at the side of Rouse Avenue, near the railway footbridge. This butterfly likes to fly back and forth in such barren areas.

Virachola isocrates—Two females, if not additional specimens, were caught in early October 1966 in company with *Rapala melampus* on a small wildflower patch in the SE corner of the Humayun's Tomb compound.

Chilasa clytia—form **dissimilis**—large size mimetic of *Danaus limniace*—seen on *Caesalpinia pulcherrima* at highest point of Buddha Jayanti Park, in second week of August 1967. Note :—the small form of this butterfly mimics *Danaus aglea*, especially where the latter and not *Danaus limniace* is seen.

Anticipated Aberrations.

Donahue assumed the incidence of the following aberrations :—

Danaus chrysippus dorippus—On *G. globosa* at the Nursery. Morning 9-ix-67—female. Note :—var. *alcippoides* was at no time noted.

Hypolimnas misippus inaria—Female at least two specimens were caught in the B K K area in late September and early October 1963—One of these, tagged ' Mata Sundri Road—1-x-63 ' has been given to the BNHS. I do not recall it in 1966. Two were caught in the morning 9-ix-67, one on the Nursery *G. globosa* patch, and the other by the Nursery dip path.

Hypolimnas misippus alcippoides, female—In the second week of August 1967 I caught two specimens describable only as semi *alcippoides.* I have a true *alcippoides* from Bombay.

Documented Rarities.

Hypolimnas bolina—females—see next section, on range alteration. Males—lost with most of the old collection, a specimen was caught on Lantana on an overcast day toward the end of September 1963, in the Bharatiya Kala Kendra area—no more were seen until August 1967, four being caught on the yellow Lantana hedge on the highest part of Buddha Jayanti Park, two of these being in copula—another was caught in this same period between 1-viii-67 and 15-viii-67, on the jungle track linking Buddha Jayanti Park and Talkatora Gardens, being attracted to sweat and caught on my trouserfront—one more was caught at the Nursery—morning—10-ix-67. It was at first interested in the *G. globosa* but soon shied away, seeming quite conscious of pursuit and attempting to hide.

Vanessa cardui—Recalled as common in October 1963, but only caught 'for example' because it was more dully coloured than the Canadian race—2 surviving specimens in BNHS tagged Tilak Bridge Nursery 25-x-63 and 26-x-63, brighter than Bombay race.

Argynnis hyperbius—male—Bharatiya Kala Kendra premises lawn—feeble—in the morning—16-iii-64—The weather then had not progressed to hot.

Ergolis merione—One seen and one caught in a lane near Bal Bhavan in B K K area in late September 1963—not subsequently seen.

Rapala melampus—2 or 3 caught in nullah in late October and early November 1963, one given to BNHS tagged for nullah 1-xi-63.

Leptosia nina—Several caught in nullah, where apparently not uncommon in late October and early November 1963.

Delias eucharis—Apparently common in October 1963—seen all over New Delhi and also in a garden in Civil Lines near the Buddha Vihara—Not recalled for 1966—Surviving Tagdata :—females—evening—19-ix-63 in lane near Bal Bhavan, and evening—10-xi-63 in nursery garden of Buddha Jayanti Park at north end.

Appias libythea—Common in the low area between Sardar Patel Marg and the upper reaches of the nullah in late October and early November 1963. Surviving Tagdata :—male 8-ix-63 in jungle behind Lakshminarayan Birla Mandir, female in B K K area

6-x-63, female near the Riding Ground in the Willingdon Crescent Jungle 27-x-63, male in the nullah 27-x-63. Note :—Though at that time knowing nothing of their classificatory identity, no difficulty was experienced in distinguishing this butterfly from others in flight. No sighting recalled for 1966.

Colias electo—Seen in garden of B K K premises late March 1964—specimen as dark orange as *C. myrmidone*.

Parides (Polydorus) aristolochiae—Fairly frequently seen in late September 1963, the first one being caught about 10-ix-63 in the LNB Mandir garden. Two large perfect specimens were caught in September 1966, one in the Nursery dip and the other in the NW corner of the Humayun's Tomb compound. One or two others were seen in the same period, but it seemed rarer than in 1963.

Changes in abundance reflecting possible alteration of Geographical Range.

Danaus limniace—Decidedly rare in 1963, but one specimen being caught, near Bharatiya Kala Kendra in September, a male in fair condition. It was common in Talkatora Gardens in late July 1965, just as the monsoon ' broke ' after a long stretch of unbroken extreme heat, and a week later the monsoon failed and faded almost to nothing. During the monsoon in 1966 this butterfly was slightly commoner but not seen at all times. I observed one or two battered specimens in February 1967 in the NE garden of the Humayun's Tomb enclosure. It was very common in early August 1967, second only to *D. chrysippus*. It can be noted that the good 1967 Delhi monsoon began early after unusually vicious heat in early June. The greatest concentration was in Buddha Jayanti Park. Toward the end of the first week of August 1967 the specimens seen and caught seemed without exception old, and new ones appeared in the second week. By the end of the second week they appeared to be leaving Delhi, and their numbers dwindled markedly.

Danaus genutia—Not common in 1963, dwarf specimens being seen and caught in the nullah in late October. Large specimens of fair commonness seen in May and June 1964. The monsoon began in early July and was exceptionally heavy. Numbers oscillated between abundant and scarce through August to October 1966, specimens being caught that were larger than those of races seen elsewhere in India, also a fresh large specimen caught in the NE quarter of the Nursery plot in late September 1966, where they abounded. This species was also abundant in early August 1967 both in Buddha Jayanti Park and the Nursery. The 1967 Delhi monsoon was a good one and started early.

Euploea core—Seen but not common in September 1963. Surviving specimen tagged B K K area 25-ix-63. Abundant in 1966 August, September, and October, mainly in the SE corner of the Humayun's Tomb compound. A year of curtailed monsoon. Uncommon early August 1967, a year of good monsoon.

Hypolimnas misippus—Moderate abundance in monsoon 1966. Far commoner in monsoon 1967.

Hypolimnas bolina—Moderately common 1963. Much commoner 1966. Very abundant, monsoon 1967.

Atella phalantha—Uncommon 1963, it flies at all times from the beginning of the monsoon until the cold weather. Specimens tagged nullah 21-x-63 and 27-x-63. It was commoner than before at July end 1965, and while common in the NE garden of Humayun's Tomb compound in September 1966, it was exceedingly abundant at the same time in Buddha Jayanti Park. It was very curious to note consistently that the specimens at Buddha Jayanti Park were fresh while those at Talkatora Gardens and Humayun's Tomb were all old, as if there were no communicating flight between the obviously separate broods. In early August 1967 this butterfly was markedly common in Buddha Jayanti Park.

Precis hierta—As common as *P. lemonias* or *P. almana* in late September and early October 1963, the broods of this species do not coincide with those of the other Precids. It was not common in 1966, but very common above the abundance of other Precids in Buddha Jayanti Park in early August 1967.

Miscellaneous.

Mycalesis perseus was seen in several places in Delhi. Two specimens given to the BNHS are tagged B K K area 11-ix-63 and nullah 27-x-63. Others were seen in the jungle behind the LNB Mandir.

Precis hierta was bred from larvae found on *Barleria prionitis* in Buddha Jayanti Park beginning August 1967. Pupating is from about 2200 hrs. to 1000 hrs. next day. Pupal period is 6 days, emergence about 1230 hrs. If the pupae are kept in pitch dark in daylight hours the emergence time is scrambled and postponed. Airconditioning further complicates the issue, as daytime is registered partly by temperature, it would appear. Females outnumbered males 5 to 2 in a brood of 19. Instar 2 to pupation took 6 days.

Atella phalantha female was observed laying on *Barleria prionitis*. I know of no prior record of the use of this foodplant.

Contrary to a statement in Wynter-Blyth's BUTTERFLIES OF THE INDIAN REGION the male of *Ixias pyrene* visits flowers, mainly white Lantana. As Donahue refers to the time of incidence of this species, I list surviving tagdata :—females, LNB Mandir Jungle, 1 white and 1 yellow, dated 8-ix-63—WSF male BKK area 17-ix-63—2 DSF males and 1 yellow female Upper Willingdon Crescent Jungle 21-x-63—1 yellow female same place 27-x-63. This documents the occurrence in October.

The white female of *Colotis fausta* was observed on the Ridge on 21-x-63, but not subsequently in that year.

Catopsilia pyranthe and *C. crocale* are species in respect of which debate exists concerning dimorphism. On 9-viii-66 I saw a male of *C. crocale*, black antennae, coupled with a female of *C. crocale pomona*, the sunflower yellow variety with red antennae. It seems to me that the pale lemon green and sunflower yellow females of *C. crocale pomona* differ from the pale lemon green females of *Crocale crocale* in just the same way as the females of *C. pyranthe florella* differ from the females of *C. pyranthe pyranthe*. In addition to this, *C. crocale pomona* has 6 basic forms, both sides sunflower yellow, UP Lemon Green and UN SY, UP and UN LG, and each of these var. *catilla*. The incidence of these forms seems to depend on locality. Concerning the specific identity, it seems that *C. pyranthe* and *C. crocale* are basically bimorphic. Series of *C. scylla* would probably involve similar parallels, including the alternation of antennae colour, though I see none recorded.

Eco-Toxicology and Control of Indian Desert Gerbil, *Meriones hurrianae* (Jerdon)

IX. Ecological Distribution in the Rajasthan Desert

BY

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(*With a map and a plate*)

[*Continued from Vol.* **68** (3) : 725]

The Indian Desert Gerbil, *Meriones hurrianae* (Jerdon) is the most abundant rodent in the Rajasthan desert. It occurs in sandy, gravelly and ruderal habitats, but shows a preference for the first one. It appears that it is more commonly found in grasslands having *Aristida* spp. as the chief component. Among the crop fields, the frequency of desert gerbil is highest in cotton-wheat fields among irrigated crops, and in the *bajra* fields among rain-fed crops. In most of the Rajasthan desert it is associated with *Gerbillus gleadowi* but in districts receiving comparatively higher rainfall, *Tatera indica* and *Rattus meltada pallidior* also occur with it. The relative abundance of *M. hurrianae* in various regions of the Rajasthan desert and its frequency in different vegetational communities are discussed.

INTRODUCTION

On the basis of extensive trapping, attempts have been made to discuss the distribution of the Indian Desert Gerbil, *Meriones hurrianae* (Jerdon) in Rajasthan desert with reference to various habitat and vegetation types, its relative abundance and its interactions with other rodents. It has been observed that the merion gerbil occurs in a variety of habitats and vegetation types, and is the most abundant rodent of this desert.

METHODS

The Indian Desert Gerbil, *Meriones hurrianae* (Jerdon) was collected at one locality in each of the eleven administrative districts of the Rajasthan desert. At each locality trapping was carried out in four habitats, namely, sandy, rocky, gravel plains and ruderal (villagecomplex).

In each habitat, two trap lines, containing 30 snap traps in each line at an interval of 10 metres, were fixed in a homogenous vegetational community. The two trap lines were 15 metres apart from each other and were run for 72 hours. Snap traps were baited with peanut butter. The frequency of *M. hurrianae* is expressed as the percentage of total number of rodents collected in a habitat and in a locality. Observations on their ecological distribution were also made in the field.

Observations and Discussion

Ecological distribution :

Among the Indian Desert Gerbil, *Meriones hurrianae* (Jerdon) collected during the survey, 60 per cent were from sandy habitat, 17 per cent from gravel plains, and 23 per cent from the ruderal habitat. No merion gerbil occurred in the rocky habitat. This analysis suggests that the rodent shows a habitat preference for the sandy environment.

Sandy habitat : In the sandy habitat, *M. hurrianae* inhabits a variety of sub-habitats. It mostly occurs on the sandy plains and in the interdunal regions. It does not occur on the undulating mobile sand dunes. On the sandy plains as well, it prefers hummocky landscape, which is formed due to a higher density of bushes like *Capparis decidua*, *Calligonum polygonoides* and *Zizyphus nummularia*. The drifting sand, blown by the strong desert winds, piles around the bushes, giving a hummocky look to the topography. The desert gerbil concentrates its burrows over the hummocks and around it (photograph 1). This type of denning behaviour puts gerbils in an advantageous position, especially in the summer season since due to the presence of extensive root system of the bushes, a higher humidity is maintained in the soil surrounding it, and in their burrows also thus enabling them to withstand the desert temperatures comfortably. This micro-climate, higher relative humidity and low temperature (Prakash *et al.* 1965) in the burrows also assist them in maintaining a balanced state of homoestasis.

During the rainy season, the sand dunes are temporarily stabilised and the rodents move to these dunes from the interdunal regions, mainly for foraging since a wide variety of vegetation sprouts on them. At Bikaner, it has been observed that the dunes were completely colonised by the desert gerbils and the spacing in between their burrow openings was even less than half a metre. Excavation of their burrows revealed that, on the temporarily fixed dunes, they do not dig extensive burrow systems but thrive in straight tunnels, from a metre to three metres long. These rainy-season-tunnels do not penetrate deep into the soil and are only 5 to 10 cm deep.

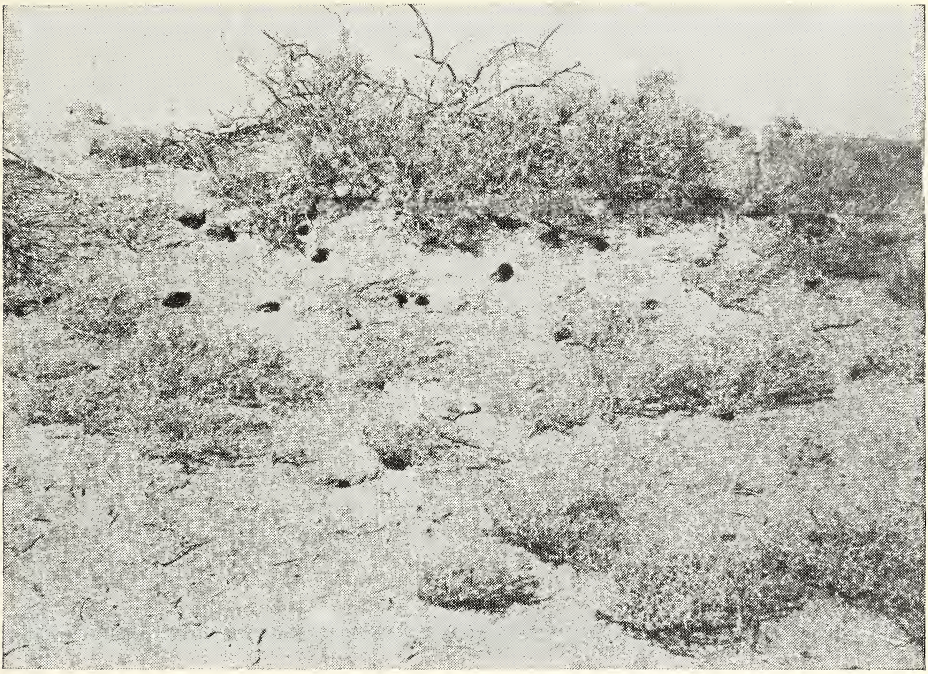
In the Sri Ganganagar district, the landscape of most parts of this district has changed from undulating sandy plains to flat, irrigated crop fields during the last 40 years, after the advent of the Ganga Canal. The desert gerbils were as prolific in this district in the pre-canal period, as they are now in any other sandy plain of the Rajasthan desert (Prakash 1958). The numbers of the desert gerbil have now been drastically reduced indirectly due to the influence of the present day land use pattern. Now, *M. hurrianae* occurs near crop fields on uplands where patches of sandy soil are distinct. Throughout the crop fields, where the soil is clayey and consolidated, desert gerbils are not found and they are replaced by *Nesokia indica*, *Tatera indica indica* and *Rattus meltada pallidior*. Taber *et al.* (1967) have also observed that the desert gerbil was once much more commonly distributed through the Lyallpur region in Pakistan. Land levelling for irrigation destroyed the interspersion of dry mounds for burrowing and moist depressions for feeding. Consequently, their numbers have also reduced in Lyallpur over the past century due to the introduction of irrigation.

At certain localities in the desert, the drifting of the sand dunes is checked by hillocks and a huge amount of sand is deposited at the foot of the hill (Barmer, Jodhpur, Jaisalmer and Jhunjhunu districts). At times, such deposits reach 250 to 350 metres above the hillocks. When the sand accumulation is fresh, unstabilised, and is composed of loose soil *Gerbillus gleadowi* migrate to it but as gradually the soil stabilises, *G. gleadowi* are more or less replaced by *M. hurrianae*.

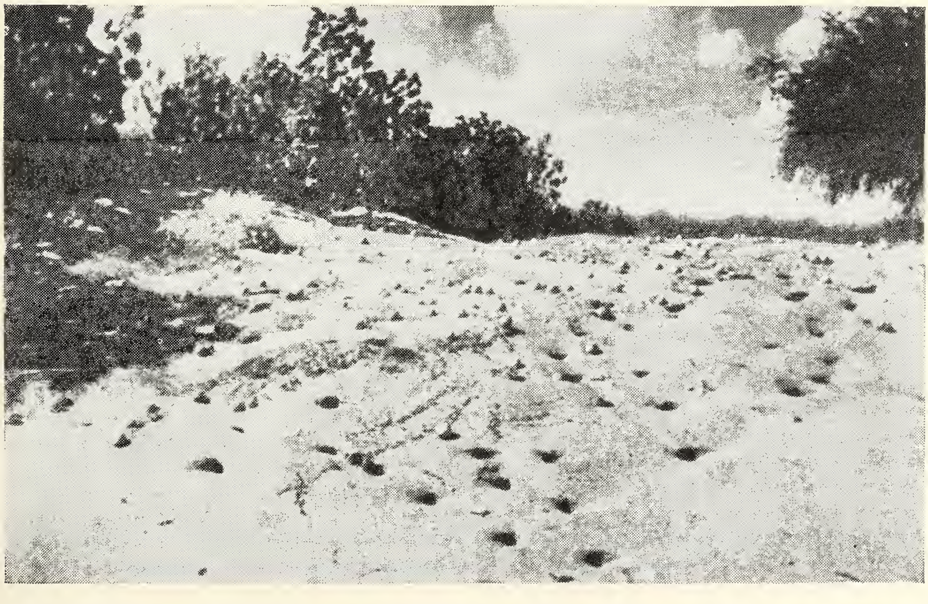
Included in the sandy habitat, we find the desert gerbils in the salt plains near Sambhar Lake, Pachbhadra and Didwana regions. Their burrows are found even in the salt pits, indicating that they can tolerate a high level of salt in the soil without any apparent effect. The desert gerbils in the Pachbhadra salt region, however, look paler than those found in other localities and the hairy tuft at the tip of their tail is brownish-sandy in colour instead of the usual black colour.

Gravelly habitat : There are two chief types of gravel plains found in the Rajasthan desert, one is composed of hard rock pebbles (Jaisalmer-Barmer district) and the other type is chiefly due to a large number of calcium carbonate concretions which are formed due to upward movement of calcium carbonate, by leaching of soil (Nagaur, northern Jodhpur, and Jhunjhunu districts). The desert gerbils do not occur in the first type of gravel plain but commonly occur in the latter, usually in depressions where the grasses and other vegetation grow which provide forage for them.

Ruderal habitat : Our definition of the ruderal habitat includes rather a number of sub-habitats which are influenced by man. Certain villages, and the micro-villages, locally known as 'Dhani', are situated over sand dunes. The Hairy-footed Gerbil, *Gerbillus gleadowi* is the most common rodent around them but *M. hurrianae* occurs in the mud-



1. Desert Gerbils concentrate their burrows over the hummocks surrounding the bushes (*Calligonum polygonoides* in this photograph)



2. Burrow openings of *M. hurrianae* in association of the cucurbit *Citrullus colocynthis*

(*Photos : Ishwar Prakash*)

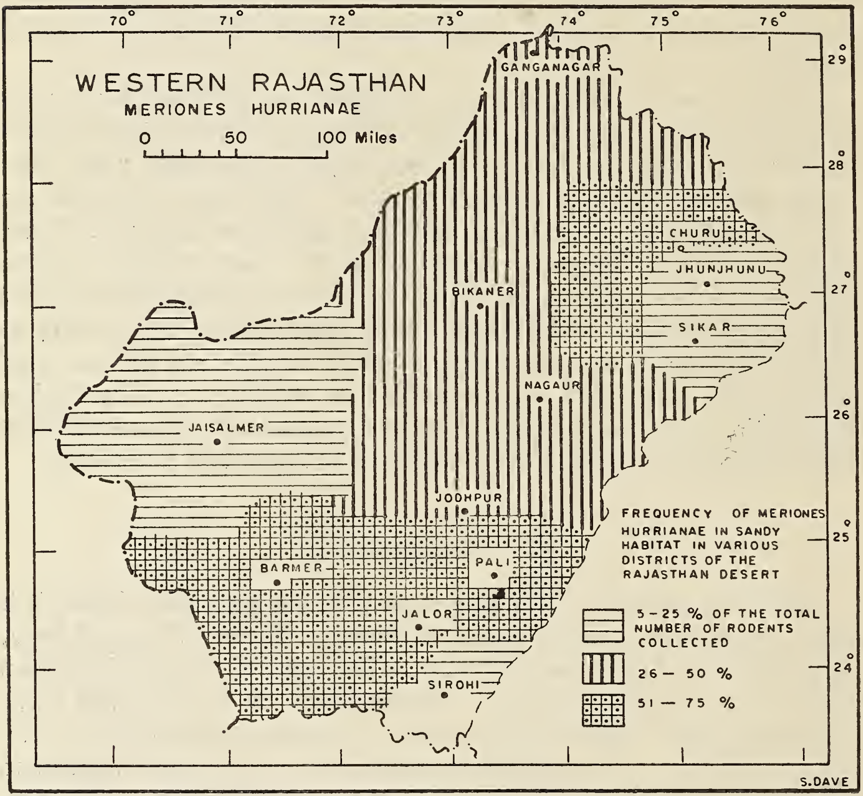
thorn clad, fences of the dhani or a house. These gerbils do not actually enter the houses which are inhabited by *Rattus rattus* and *Mus musculus* but occur in the backyard, cattle sheds etc. Whether these gerbils thrive on the natural vegetation or depend on man for food is not known precisely.

Prior to pre-monsoon showers, the fields are ploughed for sowing the *kharif* crops. Due to ploughing activity, burrows of desert gerbils are destroyed and they migrate to the fringes of the fields where they re-establish themselves in shallow burrows. Soon after the crops are harvested, two types of their distributional patterns are observed. Some immigrate into the harvested fields and quite a large number colonise the small patches where the crop is stacked (Photograph 2) and the places where crop grains are being threshed from ears. I have seen as many as 40 desert gerbils in an area of 15 sq metres, foraging on the harvested crops. They also inflict severe damage to standing crops by feeding upon entire plants in early stages of growth and later by cutting the plant and then feeding upon the ripe seeds, both in *kharif* and *rabi* crops.

RELATIVE ABUNDANCE

While *M. hurrianae* is distributed all over the Rajasthan desert, it is more abundant in the sandy habitat at Jodhpur, Barmer, Nagaur, Churu, Jhunjhunu and Sikar districts (Map). The map of western Rajasthan shows their relative abundance, the frequency of *M. hurrianae* being calculated as per cent of total number of rodents collected in the trap lines in 72 hours. The relative abundance of the desert gerbil appears to be associated with the soil types. In the western districts (Jaisalmer, Bikaner and part of Barmer), the topography is dominated by drifting sand dunes and a lower number of desert gerbils frequent there. In the northern district of Sri Ganganagar, their frequency is low due to the altered land use pattern due to irrigation cropping. In the south-eastern districts of Pali and northern Sirohi, the soil is too clayey and here their numbers are low. In one of our earlier communications (Prakash *et al.* 1971), we had stated, on the basis of quantitative data, that *M. hurrianae* numbers and the clay per cent in soil are inversely proportional. But in the central and south-eastern districts the soil is 'Red-desertic' type (Roy & Sen 1968) and considering their abundance in this region it appears that this soil type is most suitable for them.

Relative abundance in relation to vegetation: Table 1 summarises various vegetational communities in which rodent trapping was done in different habitats, per cent basal cover of vegetation, and the frequency of *M. hurrianae* as per cent of the total number of rodents collected. It is evident that the desert gerbils are found in almost every vegetation type due to their versatility to adapt to a wide variety of food (Prakash 1962, 1969). It appears from the table that gerbils are more common in communities having *Aristida* spp. as a dominant grass. Earlier we had observed (Prakash *et al.* 1971) that at six localities in the three bio-climatic zones of the Rajasthan desert the largest number of this gerbil was associated with the grass *Aristida*. It has also been found that the desert gerbils shift their burrows near the creeper, *Citrullus colocynthis*, when it fruits. A burrow opening can be found near and under every fruit (Photograph 3). The fruit is scooped and seeds eaten right from the burrow, without exposing the rodent to climatic and predatory hazards. *M. hurrianae* shuns localities where an abundance of grasses like *Cenchrus biflorus* and *Erianthus munja* grow. The ripe inflorescence of *C. biflorus* is very spiny, which sticks to their body and makes life difficult for the gerbils (Prakash 1964). In the 100 mm rainfall region in the extreme west of Jaisalmer district, *M. hurrianae* were found to be associated with the perennial bush, *Haloxylon salicornicum*. Association of this rodent with this bush has also been observed in North Africa by Petter (1961).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NAGAUR
JAISALMER
JODHPUR
BARMER
PALI
JALOR
SIROHI
FREQUENCY OF MERIONES HURRIANAE IN SANDY HABITAT IN VARIOUS DISTRICTS OF THE RAJASTHAN DESERT
5 – 25 % OF THE TOTAL NUMBER OF RODENTS COLLECTED
26 – 50 %
51 – 75 %
S.DAVE

Distribution and relative abundance of *M. hurrianae* in Rajasthan

Relative abundance in relation of basal cover of vegetation: It is evident that basal cover of the vegetation does not influence the relative

TABLE 1

PER CENT BASAL COVER IN DIFFERENT VEGETATION COMMUNITIES AND RELATIVE ABUNDANCE OF *M. hurrianae* IN SANDY HABITAT

Chief vegetation community	% Basal cover of vegetation	Percent frequency of *M. hurrianae*
Tephrosia purpurea—Aerva pseudo-tomentosa—Aristida spp. ..	0·1	53·3
Eleusine compressa—Cyperus arenarius—Calligonum polygonoides ..	3·2	27·2
Lasiurus sindicus—Cenchrus biflorus—Blepheris sindicum ..	6·9	25·0
Cyperus arenarius—Aristida spp.—*Crotalaria burhia* ..	1·0	24·2
Cyperus arenarius—Cenchrus biflorus—Crotalaria burhia ..	1·3	75·0
Pulicaria wightiana—Sesbania aegyptiaca—Aristida spp. ..	8·9	35·5
Sporobolus helvolus—Desmostachya bipinnata—Acacia jacquemontii ..	6·2	54·5
Panicum turgidum—Eleusine compressa—Dactyloctenium scindicum ..	0·8	75·0
Dichanthium annulatum—Eremopogon faveolatus—Aristida spp. ..	7·3	present
Cenchrus setigerus—Eleusine compressa—Aristida spp.	1·0	25·0
Zizyphus nummularia—Cenchrus biflorus—Aristida spp.	3·4	28·9
Gram field ..	—	20·0
Cotton-wheat field ..	—	57·1
Bajra-chilli field ..	—	44·5

numbers of the desert gerbils (Table 1). Seventy-five per cent of the rodents trapped were *M. hurrianae* where the basal cover was only 1·3 and 0·8 per cent respectively, whereas in vegetational communities where the basal cover was high, 7·3, 3·4 and 3·2 per cent, the relative abundance of desert gerbils was not more than 27·2 per cent (Table 1). But in the *Sporobolus-Desmostachya-Acacia* community, where the basal cover was comparatively high (6·2 per cent), the frequency of merion gerbils was also high (54·5 per cent). These findings indicate that the basal cover of vegetation and the frequency of desert gerbils do not have any definite and apparent relationship.

RODENT ASSOCIATES

In the western districts of the desert, *M. hurrianae* is associated with the Hairy-footed gerbil, *Gerbillus gleadowi* and Wagner's Gerbil, *G. nanus indus* (Table 2). In some of the districts, *Rattus gleadowi* and *Mus platythrix sadhu* are also found along with *M. hurrianae*. In the south-eastern districts which receive comparatively more rainfall, *Rattus meltada pallidior* occurs with them along with *Tatera i. indica*. In the gravel plains it lives in association of *T. i. indica* and in the ruderal habitat along with *R. m. pallidior*. More extensive work, which is being taken up, will probably throw some light on the intricate interactions between the various rodent species which inhabit the same habitat.

TABLE 2

RODENT ASSOCIATES OF *M. hurrianae* IN THE RAJASTHAN DESERT

Rajasthan desert districts	Rodent associations (based on frequency of trapping, first species being the most abundant)
	Sandy Habitat
Barmer ..	*Meriones hurrianae—Gerbillus gleadowi*
Bikaner ..	*M. hurrianae—G. gleadowi—Gerbillus nanus indus—Rattus gleadowi*
Jaisalmer ..	*G. gleadowi—G. n. indus—M. hurrianae*
Jodhpur ..	*M. hurrianae—Rattus meltada pallidior—Tatera indica indica*
Jhunjhunu and Sikar	*G. gleadowi—T. i. indica—M. hurrianae*
Churu ..	*M. hurrianae—G. gleadowi*
Nagaur ..	*M. hurrianae—T. i. indica—R. m. pallidior*
Pali ..	*M. hurrianae—T. i. indica*
Jalore ..	*M. hurrianae—G. gleadowi*
Sirohi ..	*M. hurrianae—R. m. pallidior—T. i. indica*
	Gravelly Habitat
Rajasthan desert ..	*M. hurrianae—T. i. indica*
	Ruderal Habitat
Rajasthan desert ..	*T. i. indica—R. m. pallidior—M. hurrianae*

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Systematic Status of *Carangoides malabaricus* (Schneider, 1801) and *Carangoides caeruleo-pinnatus* (Rüppell, 1828) [Pisces : Carangidae]

BY

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INTRODUCTION

Considerable confusion exists about the status and identity of *Caranx malabaricus* Schneider, 1801, originally described from Tranquebar (south-east coast of India) and *Caranx caeruleo-pinnatus* Rüppell, 1828, from the Red Sea. The original descriptions of both species are inadequate and the type material lost (*vide* Williams 1958).

Rüppell's (1835) figure of *Caranx caeruleo-pinnatus* shows the breast naked (without scales) up to the end of the pelvic fin ray.

Günther (1860) while describing *Caranx malabaricus* Schneider considered *Caranx caeruleo-pinnatus* Rüppell, 1828, as a synonym of the species, an opinion accepted by Klunzinger (1871), Day (1876), Weber & de Beaufort (1931) and Williams (1958).

Day (1876) described *Caranx malabaricus* Schn. and figured an 8 inch specimen from Madras which was considered by Klunzinger (1884) as a synonym of his new species *Caranx impundicus*, since the naked area of the breast extended up to the anal fin and the curve of the lateral line joined the straight section before the middle of the anal fin. Weber (1913) considered both these characters of dubious and insignificant taxonomic importance.

Fowler (1925 and 1934) distinguished *Carangoides malabaricus* (Schn.) from *Carangoides caeruleo-pinnatus* (Rüpp.) on the gill raker number. Later, Fowler (1927) collected five specimens from Bombay which, according to him, agree with Day's (1876) figure of *Caranx malabaricus* (Schn.)

Weber & de Beaufort (1931) while describing *Carangoides malabaricus* (Schn.) queried the validity of *Caranx malabaricus* of Day (1876) and *Caranx impundicus* of Klunzinger (1884).

In a recent review on ' Fishes of the family Carangidae in East African waters ', Williams (1958) treated *Caranx caeruleo-pinnatus*

Rüppell as a junior synonym of *Carangoides malabaricus* (Schn.), and described a closely allied new species, *Carangoides rectipinnus*, based on a single example from Zanzibar. He considered *Caranx malabaricus* of Day (1876) and Fowler (1925 and 1934), and *Caranx impundicus* of Klunzinger (1884) as probable synonyms of his new species.

From a careful examination of twenty-eight specimens [including Day's (1876) figured specimen and topotypes] available in the collections of the Zoological Survey of India, it has been possible to conclude that: (1) *Carangoides caeruleo-pinnatus* (Rüppell, 1828) is distinct from *Carangoides malabaricus* (Schneider, 1801); (2) *Caranx impundicus* Klunzinger, 1884 and *Carangoides rectipinnus* Williams, 1958 are junior synonyms of *Carangoides malabaricus* (Schneider, 1801).

In this paper the synonyms, distinguishing characters, detailed description and distribution of *Carangoides malabaricus* (Schneider) is given based on the material and literature studied. The synonyms, distinguishing characters and distribution, based on literature, of *Carangoides caeruleo-pinnatus* (Rüppell) is also given. The morphometric measurements were made in accordance with the method described by Williams (1958).

Notes on the Species

Carangoides malabaricus (Schneider), 1801

Scomber malabaricus Schneider, 1801, p. 31 (Tranquebar, India).

Caranx malabaricus Cuvier and Valenciennes, 1833, p. 121; Bleeker, 1845, p. 517; Cantor, 1850, p. 1110; Günther, 1860, p. 436; Day, 1876, p. 221, pl. 50, fig. 2; Weber, 1913, p. 394; Wakiya, 1924, p. 178, pl. 23, fig. 3; Weber and de Beaufort, 1931, p. 237; Blegvad, 1944, p. 98; Smith, 1953, p. 217; Menon, 1961, p. 388.

Carangoides talamparah Bleeker, 1852, p. 64 (East Indies).

Carangoides talamparoides Bleeker, 1852, p. 91 (East Indies).

Caranx talamparoides Günther, 1860, p. 437.

Caranx impundicus Klunzinger, 1884, p. 99 (Red Sea).

Caranx caeruleo-pinnatus Wakiya, 1924, p. 179, pl. 25, fig. 1.

Carangoides malabaricus Fowler, 1925, p. 212; 1927, p. 774; 1934, p. 447; Munro, 1955, p. 127.

Citula malabaricus Misra, 1959, p. 238.

Carangoides rectipinnus Williams, 1958, p. 401, pl. 10, fig. 13 (Zanzibar).

MATERIAL EXAMINED (28 specimens):

No. 254.	1158 mm, Madras, *c*. 1876, F. Day; Original of pl. 50, fig. 2.	
No. 1011.	1139 mm, Madras, *c*. 1876, F. Day.	
No. 8731.	176 mm, Burma, *c*. 1876, F. Day.	
No. 8723.	157 mm, Burma, *c*. 1876, F. Day.	
?	166 mm, Burma, *c*. 1876, F. Day.	
No. 10332.	1206 mm	Bushire, *c*. 1870, W. T. Blanford. (Persian Gulf).
No. 10333.	1216 mm	
No. 10334.	1234 mm	
No. 10335.	1189 mm	

No. 12271.	1156 mm,	Orissa,	11/1/1889,	'Investigator'.
No. 14041.	192 mm,	Bengal,	?	, C. Woolward.
No. F. 4921/2.	467–139 mm,	Andhra,	23/1/1929,	H. S. Rao.
No. F. 4858/2.	1111 mm,	Goa,	*c.* 1938,	?
No. F. 1760/2.	260–64 mm,	Karwar (Mysore),	20/2/1956,	K. K. Tiwari.
No. F. 607/2.	1122 mm,	Bay of Bengal,	1957,	'Bengal Fisheries'.
No. F. 1120/2.	2131–137 mm,	Tranquebar,	6/2/1957,	A. G. K. Menon.
No. F. 1127/2.	2113–141 mm,	Pondicherry,	22/12/1959,	A. G. K. Menon.
?	454–147 mm,	?	?	?
—	184 mm,	Madras,	5/11/1966,	T. Sivaprakasam.

Distinguishing characters of the species:

Carangoides with breast naked (without scales) extending up to the anal fin; scutes on lateral line less than 30; 23-26 gill rakers on lower arm of first arch.

Description:

D VIII+1·21-23 (in Day's original of pl. 50, fig. 2, the 12th ray not developed).

A II+1·17-18; P I. 20-21.

Scutes on lateral line straight, 23-25, weak.

Gill rakers on first arch 8-10+1+23-26, lanceolate.

Depth of body 2·0-2·2 (1·6-2·0 in juveniles); length of head 2·8-3·1; both in standard length. Eye diameter 2·7-3·4 (2·3-2·9 in juveniles); length of snout 2·6-3·3; interorbital width 3·5-4·1; suborbital width 6·0-7·1; postorbital length 2·5-3·2; maxillary length 2·2-2·7; pectoral fin length 0·6-1·0; pelvic fin length 2·2-3·0; 3rd dorsal spine length 2·2-2·9; 1st dorsal ray 1·6-2·2; 1st anal ray 1·7-2·3; all in length of head. Eye diameter in snout length 0·8-1·3. Lateral curve in lateral line straight 0·6-0·8.

Body strongly compressed, ovate in young, becoming subovate in large adults; caudal peduncle slightly wider than high. Nape elevated, becoming depressed with age. Head higher than long in young, about as high as long in adults. Cleft of mouth below level of eye, oblique. Jaws highly protrusible, lower jaw the longer. Maxilla reaches front edge of pupil. Operculum entire. Lateral line anteriorly with a long shallow arch, joins lateral line straight under 12th-13th dorsal ray, but the joint never very distinct.

Teeth: Villiform, in bands in both jaws; a band of minute teeth on tongue, vomer and palatines.

Scales: On body small; breast naked ventrally and laterally in a triangular area from spine of anal fin to beyond pectoral fin base. A few scales on cheeks and postorbital area, rest of head naked.

Fins: Third dorsal spine longest, second and fourth nearly as long. Soft dorsal and anal fins only very slightly elevated anteriorly; basal sheath to both fins. Pectorals falcate; pelvics short. Caudal widely forked, lobes equal.

Distribution: East coast of Africa, Zanzibar, Red Sea, Persian Gulf to India, Ceylon, Burma, the East Indies, Philippines and Japan.

Carangoides caeruleo-pinnatus (Rüppell), 1828.

Caranx caeruleo-pinnatus Rüppell, 1828, p. 100; 1835, p. 47, pl. 13, fig. 2.
Caranx malabaricus Klunzinger (*nec.* Schneider), 1871, p. 463; 1884, p. 99.
Carangoides caeruleo-pinnatus Fowler, 1934, p. 448.
Carangoides malabaricus Williams, 1958, p. 402, pl. 11 & 12.

Distinguishing characters of the species:

This species is very close to *Carangoides malabaricus* (Schneider) but is distinguished from it in having 14-18 lower gill rakers (*versus* 23-26). Further, the breast is naked up to the inner pelvic ray, when depressed, only.

Distribution: Red Sea and the east coast of Africa.

REMARKS

As stated earlier, the 28 specimens studied from the Persian Gulf, India and Burma (including Day's figured specimen and topotypes) have 23-26 gill rakers in the lower arm, and the breast is naked up to the end of the pelvic fin ray, when depressed. Since no specimen of *Carangoides malabaricus* with a lower gill raker count, namely 13-19 and the breast naked up to the anal fin, has so far been reported from Indian waters, Schneider's (1801) type of *Caranx malabaricus* was probably a specimen with a higher gill raker number and the breast naked up to the end of the pelvic ray, when depressed.

Williams (1958) obtained both species of *Carangoides* from East Africa but due to the confusion of the nomenclature, in the literature, he assigned different names to the two species. Williams (l.c.) apparently overlooked Fowler's (1934) description of *Carangoides caeruleo-pinnatus* since he makes no mention of it. His descriptions of *Carangoides malabaricus* (Schneider) and *Carangoides rectipinnus* Williams agree so well with Fowler's (1934) descriptions of *Carangoides caeruleo-pinnatus* (Rüppell) and *Carangoides malabaricus* (Schneider) respectively, that his failure to use the name *caeruleo-pinnatus* is not clear.

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On the behaviour of Blue Sheep (*Pseudois nayaur*)

BY

GEORGE B. SCHALLER

(*With two plates, a map and two text-figures*)

Blue sheep (*Pseudois*) are morphologically similar to both sheep (*Ovis*) and true goats (*Capra*). The main purpose of a brief study on a small population of blue sheep in eastern Nepal was to find out if the species is behaviourally allied to sheep or to goats. Several courtship displays and various forms of aggression, such as the methods of clashing horns, are described and quantified. And these show that blue sheep resemble goats in their behaviour.

Sheep of the genus *Ovis* can be distinguished from goats of the genus *Capra* by such physical characters as the presence of preorbital glands, interdigital glands on all feet, and the absence of a beard. The tribe Caprini, to which sheep and goats belong, also contains two genera, each represented by a single species, whose phylogenetic position remains unclear because the animals are morphologically allied both to *Ovis* and *Capra*. One is the aoudad (*Ammotragus lervia*), the other the blue sheep (*Pseudois nayaur*). In their general appearance, including the absence of a beard, blue sheep resemble *Ovis*. Males lack the strong body odor typical of goats. Furthermore, blue sheep have no callus on the knee, and the small, spindly horns of females are similar to those found in sheep rather than to the sturdy, fairly long ones that are characteristic of goats. Lydekker (1898) stated that blue sheep have interdigital glands on all feet, a sheep-like trait, but Pocock (1910) found that at least some individuals lack these glands. In other characters, blue sheep show an affinity to goats. The horns of males curve first up, then out, and finally back, like those of East Caucasian tur (*Capra cylindricornis*), and, as Lydekker (1898) pointed out, 'the structure and colour of the horns are the same as in goats'. He also found that the basioccipital bone of the skull resembled that of goats rather than sheep. Blue sheep, like goats, have markings along the anterior surface of their stocky legs, they have large dew claws, and their tail is bare underneath except at the tip. Reflecting his confusion over this combination of traits, Hodgson originally placed the species into the genus *Ovis*, but 13 years later, in 1846, switched it to a new genus, *Pseudois*. Today the blue sheep is generally considered to be an aberrant goat with sheep-like affinities (Ellerman and Morrison-Scott 1951).

Behavioural data can usefully supplement other information in solving taxonomic problems. Knowledge about blue sheep in the wild is limited largely to general comments (Wallace 1913; Burrard 1925; Stockley 1928; Schäfer 1933, 1937; Dang 1968) and hunting accounts (Markham 1854; Fergusson 1911; Hayden & Cosson 1927). While some of these reports contain useful information, particularly those by Schäfer, none describe behaviour of blue sheep in detail. Research on sheep and goats in zoos has contributed importantly to an understanding of the Caprini (Haas 1958; Walther 1961), but, as Crandall (1964) noted, 'the blue sheep has now become extremely rare in collections'; captives have never been studied. I spent March 1 to 3 and March 9 to 19, 1972, on a wildlife survey in the upper Kang Chu Valley (86° 12′ E, 28° 7′ N) of eastern Nepal. Although contact with blue sheep was limited to 54 hours of observation on 11 days, my notes help to clarify the taxonomic status of the species.

The blue sheep lives in one of the most remote regions on earth. Its range stretches from Baltistan in Kashmir eastward across the Tibet province and into the Yunnan, Szechwan, Kansu, and Shensi provinces of the People's Republic of China. The Kuenlun and Altyn-tag ranges form the northern boundary of its distribution and the crest of the Himalayas the southern (Burrard 1925; Schäfer 1933). Most blue sheep in Nepal are located in the western portion, along the edge of the Tibetan plateau, but in a few localities, such as on the western and southern flanks of Mt. Dhaulagiri and along the upper Arun River in eastern Nepal, they have penetrated into the Himalayan Range (Map). The animals avoid wooded terrain, being usually found above the thickets of juniper, birch, and other stunted trees that mark timberline. Generally they occur from an altitude of about 3500 m upward to at least 5500 m (Burrard 1925), but in the eastern part of their range they may be seen as low as 2700 m (Schäfer 1937). 'In a word, what they delight in is good grazing ground in the immediate vicinity of rocky fastnesses . . .' (Kinloch 1892). This was also the case in my study area. The Kang Chu divides near the headwaters, each fork soon entering Tibet. On the Nepal side of the border, blue sheep inhabit only a small range between these forks. This range has two characteristics which make it good sheep habitat: (1) good grazing is available on the gradual lower slopes as well as on the adjacent cliffs, which, though steep, are covered with many ledges, terraces, and small plateaus in contrast to the surrounding mountains which present relatively unbroken and barren expanses of scree and rock faces; and (2) the slopes, with their southern exposure, are free of snow over a month before those on the opposite sides (Plate I, *above*). During my stay, the blue sheep were generally low on the slopes, at an altitude of about 4000 m, in the early morning, then slowly retreated uphill as yak herdsmen became active in the valleys.

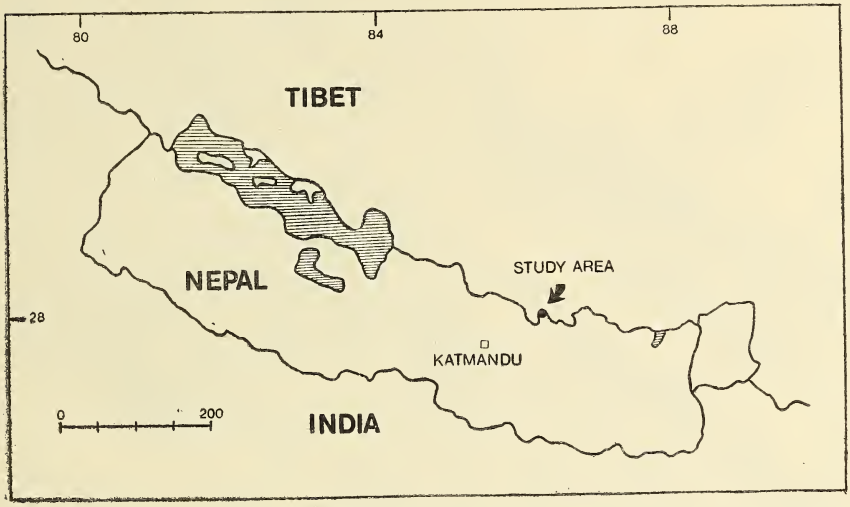


FIG. 1. The approximate distribution of blue sheep in Nepal. The distribution in the western part is not as continuous as indicated but more precise information is not available.

DESCRIPTION OF ANIMALS

Blue sheep were divided into several age and sex classes based on size, pelage colour, and, in the case of males, also on the number of horn rings which are often discernible at a distance. The descriptions below are limited to characters which I found useful for distinguishing the various classes ; detailed accounts can be found in Lydekker (1898) and Schäfer (1937). The ages of males are given as they were estimated at the time of the study.

Class IV male (fully grown, at least 7 to 8 years old). Adult males are stocky animals, almost 1 m tall at the shoulders, and with a weight of as much as 60 to 75 kg (Schäfer 1937). Their winter coat is a striking slaty-blue in colour, which contrasts with their white abdomen, small white rump patch, and white insides of the legs. A conspicuous black flank stripe separates the upper from the underparts. The anterior parts of the forelegs are also black, except for the white knees, as are the anterior edges of the hindlegs, the chest, and the centre of the tail. Black streaks run along the top and sides of the muzzle. The smooth horns flare far backwards at the tips and are an estimated 60 cm or more long ; Lydekker (1898) mentioned several record horns with lengths of 75 to 81 cm. The oldest ram I aged was about 9 years, but Schäfer (1937) shot one 13 to 15 years old.

Class III male (almost 5 years to almost 7 years old). Males of this class resemble class IV males except that they are slightly less heavy in build and they have shorter horns, measuring about 45 to 55 cm in length (Plate I, below).

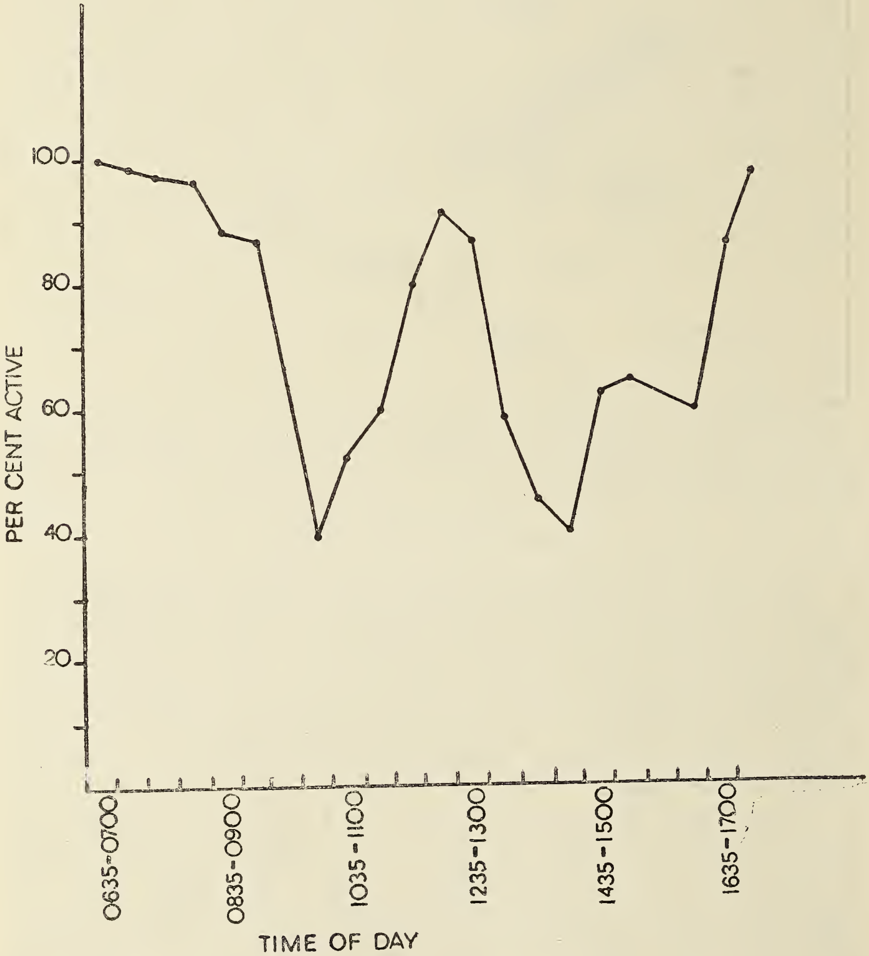


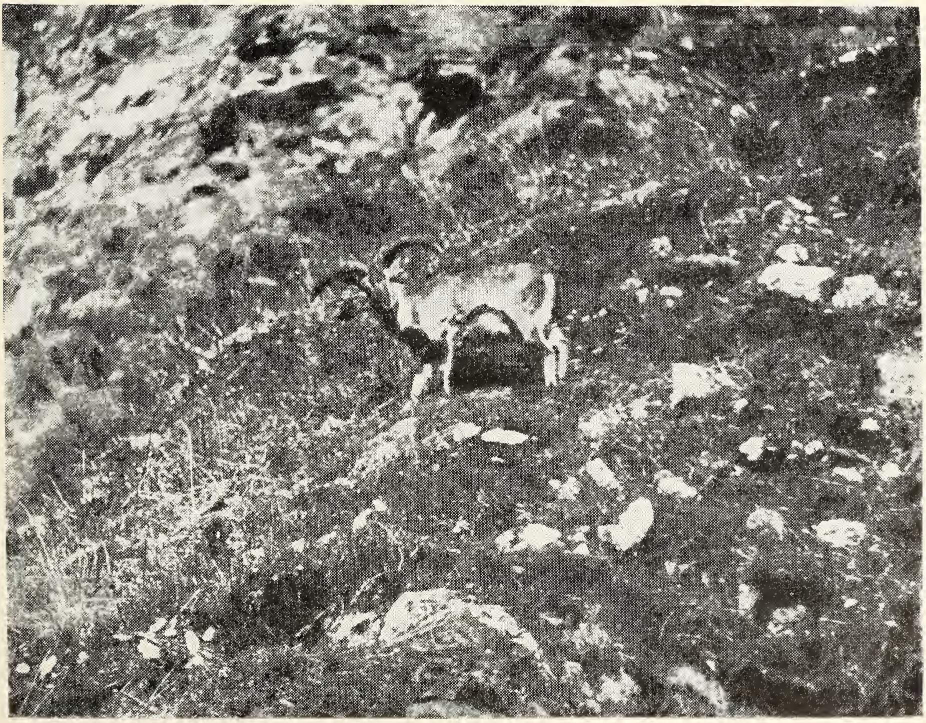
Fig. 2. Per cent of blue sheep active at various times of day, 0635 to 1730 hours.

Class II male (almost 4 years old). The flank stripe of these young adult males is either absent or only faintly visible. The horns curve up and out, but barely back, and they are about 35 cm long (Plate II).

Class I male (almost 3 years old). These subadult males are of about the same size as adult females. They lack a flank stripe, and their horns do not flare back, being only about 25 cm long.

Schaller : Blue Sheep

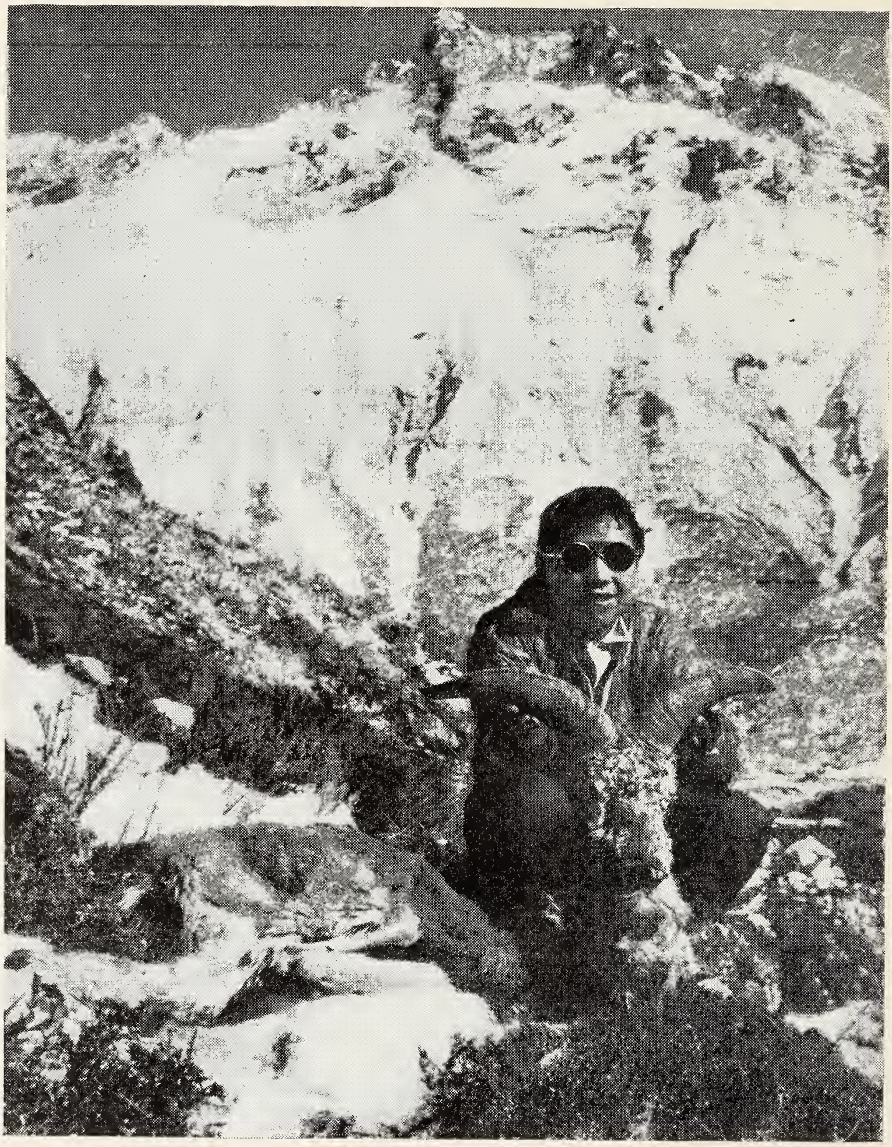
Habitat of the Blue Sheep in the Kang Chu area of Nepal



A Class III male, Kang Chu, Nepal

(*Photos: George B. Schaller*)

Schaller : Blue Sheep



Carcass of a Class II male killed by a Snow Leopard

(*Photo: George B. Schaller*)

Yearling male (almost 2 years old). Yearlings are two-thirds the size of adult females, and, like class I males, they lack a flank stripe. The horns are about 15 cm long.

Females. Adult females are considerably smaller than adult males, weighing only 35 to 45 kg (Schäfer 1937). Their pelage colour is similar to that of males except that it lacks the richness in hue. Lydekker (1898) wrote : ' In the females the black markings on the face, chest, and flanks wanting '. The animals I studied had dark chests and some also had black facial and flank markings. The horns are spindly and short, curving up and out. Yearling females are smaller than adult ones.

Young (almost 1 year old). Young are much smaller than yearlings and their straight horns are about 5 cm long. A woolly cap of hair covers their crown, a feature also seen in some females. Young still followed females closely even though they were weaned, judging by the fact that occasional suckling attempts were rebuffed.

POPULATION AND HERD DYNAMICS

The slopes in the study area were searched almost daily for blue sheep. At least one small herd could usually be found, often the same one in the same locality for several successive days. The highest count on any one day was 33 animals, and other known individuals raised the minimum number in the area to 48. Some blue sheep were no doubt overlooked, but it seems unlikely that there were more than 75.

I classified 216 animals, many of them repeatedly in the course of the study, and the composition of the population was as follows: class IV male 3·7%, class III male 9·3%, class II male 6·5%, class I male 10·6%, yearling male 11·1%, adult female 25·9%, yearling female 10·2%, and young 22·7%. Males of classes I to IV somewhat outnumbered adult females, but this may either be a sampling bias or the small study population, located at one end of a mountain range, may not be quite typical of the population as a whole. I suspect that the sexes in adults are represented about equally, as they are in yearlings. There were 87 young to 100 adult females, a high percentage, especially since those females that were almost 3 years old had not yet had their first young. The slim abdomens of yearlings as compared to the bulging ones of adults showed that females have their first young at the age of 3 years. The zoo data collected by Zuckerman (1953) and the observations made of free-living animals by Schäfer (1937) indicate that one young is the rule. This was also my impression. However, one female appeared to be accompanied by twins. The large number of young, was thus mainly attributable to good survival in 1971. The fact that the yearling percentage was 21 (82 yearlings to 100 adult females) indicated that the death rate of young animals was also low in 1970.

Two or possibly three adult snow leopards (*Panthera uncia*) hunted in the study area, and their principal prey was blue sheep, as revealed by 14 food remnants in 12 droppings of various ages: blue sheep—7; yak (*Bos grunniens*) which was known to have been scavenged—1; Himalayan marmot (*Marmota bobak*)—3; grass—1; and small amounts of unidentified hair—2. Two fresh blue sheep kills were also found. A class II male walked alone to a rivulet of water in the valley and there was stalked and captured by a snow leopard. The cat disemboweled its quarry, ate a little of it, then dragged it 150 m uphill, a sequence of events clearly revealed by the tracks in the snow. After eating on the carcass for 3 days, the snow leopard abandoned the remains, principally bones and skin (Plate II). The other kill was a class III male, almost 7 years old, captured on a boulder-strewn slope. In India, Dang (1967) found 7 blue sheep that had been killed by snow leopard and of these 6 were males. Several Tibetans in the area owned coats made of blue sheep hides, but the casual way in which sheep avoided persons and the readiness with which they entered the village of Lapche when it was unoccupied during the winter suggested that the animals there were not hunted much by man.

Group structure in blue sheep, as in many ungulates, changes with the seasons. Males tend to separate from the females after the rut (Burrard 1925; Dang 1968) and form male groups which may contain as many as 40 members (Schäfer 1937). However, a few males associate with females throughout the year (Kinloch 1892). The literature is not in agreement as to when blue sheep rut, estimates varying from September (Prater 1965) and October (Schäfer 1937) to October-November (Stockley 1928) and January (Wallace 1913). However, most authors agree that young are born between April and June, which, if a gestation period of 160 days (Crandall 1964) is accurate, would place the main rut into November and December. My observations were made after the rut was over and during a period of transition when males were in the process of leaving the females.

Group size may vary from 2 to 200 (Stockley 1928) and even 400 (Schäfer 1937). The largest group I saw numbered 22 animals, and the average of 18 group counts was 11. Schäfer (1937) found that during October an average group was composed of about 5 males of varying ages, 10 yearling and adult females, and 5 young. Dang (1968) gave the composition of one large group, and it contained 14 males, 23 females, and 19 young. The blue sheep in my study area seemed to be divided into about 3 main herds, each occupying certain slopes. Schäfer (1937) also noted that herds have preferred ranges. Herds changed composition constantly as single individuals and groups joined or parted. For example, one group consisting of 1 yearling male, 1 class I male, 1 class III male, 3 females, and 3 young was joined in the course of a morning by a solitary class I male, a group of 3 adult males (2 class III and 1 class IV), and a female with young. Another time a group of 15 animals split into groups of 10 and 5 as each moved foraging into opposite directions. All groups numbering 8 or more animals contained at least one subadult or adult male. One group of 22 blue sheep was, for instance, composed of 2 yearling males, 3 class I males, 1 class II male, 2 class III males, 2 class IV males, 3 yearling females, 6 adult females, and 3 young. But associations between males and females were obviously tenuous. Adult males often gathered at the periphery of the group, rested together some 20 m from it, and sometimes left it alone or in twos and threes. Solitary males of all ages, except yearlings, were seen.

General Behaviour

Daily activity patterns, food habits, and other aspects of ungulate behaviour are influenced by the seasons. It was late winter in the upper Kang Chu when I was there. The average daily minimum temperature was −4°C (−8 to −2°C), and the average daily maximum was 7°C (5 to 10°C), but the winds that howled off the Tibetan plateau in early morning made it seem colder. Over 0·6 m of snow fell on March 5. By March 10 the sun had exposed about half of the sheep range, and a week later most snow was gone from the lower slopes. Up to 5 cm of snow also fell on March 13, 16, and 17 but melted the same day.

Blue sheep had mainly dead vegetation available as food, although in mid-March a few green shoots began to appear. Grasses (*Festuca* sp., *Trisetum* sp., *Danthonia schneideri* and others) were by far the most important food of blue sheep. A legume (*Thermopsis barbata*) was commonly eaten, and other dry forbs (an Umbelliferae, a *Polygonum*) and ferns also contributed to the diet; one animal ate the everlasting flowers of *Anaphalis contorta.* Sheep also browsed on *Juniperus* tips and on leaves of various shrubs, including *Berberis* sp., *Cotoneaster microphyllus*, and *Ephedra gerardiana.* Several animals appeared to lick crustose lichens off rocks. The rumen contents of a blue sheep killed by a snow leopard showed the importance of grass in the diet: an estimated 98% by volume was dry grass, and the rest was *Juniperus*, *Berberis*, *Ephedra* and *Thermopsis*.

A group spent most of the daylight hours feeding on dry, snow-free sites, sometimes scattered over the slope, at other times concentrated in a small area. Burrard (1925) and Schäfer (1937) reported that blue sheep feed mainly in the early morning and late afternoon, whereas Lydekker (1898) noted no particular schedule. To find out if blue sheep have a feeding routine, I recorded the number of active and resting animals every 5 minutes. The 6 points in each half-hour period were combined and expressed as per cent of animals active in Figure 1, which is based on 8883 activity observations. At least 40% of the sheep were moving or feeding at any one time between 0635 and 1730 hours, but there were activity peaks before 0930 hours, between 1130 and 1300 hours, and after 1635 hours. Even during rest periods one or more members of a group were usually foraging. Occasionally one pawed the ground 2 to 6 times before eating items which I could not identify. Such pawing may also occur on rare occasions before an animal lies down. Blue sheep rest either with legs tucked beneath them, or with one or both forelegs stretched forward. Choice of rest sites seemed fairly haphazard as long as the ground was dry, a ridge top, an outwash plain, the depth of a ravine, without reference to sun, wind, or visibility. I found no evidence to support Kinloch (1892), Fergusson (1911), and others who claimed that blue sheep have sentries. However, the fact that at least one animal was usually moving around made it difficult to venture close to a group undetected. Domestic yak were not avoided, the two species sometimes being within 10 m of each other, but the slow approach of a person from the valley caused blue sheep to walk or run uphill. Sometimes an animal halted and stamped a forefoot as it alertly peered down at the source of danger. Many authors have reported that blue sheep also give sharp whistles in such circumstances. When disturbed, an adult female usually led the retreat of a large group. This was the case in 9 out of 10 instances observed, the exceptional leader being a class III male.

COURTSHIP DISPLAYS

I did not observe courtship behaviour except for a few isolated displays. These are described here so that they may contribute to a later discussion of the evolutionary affinities in the behaviour of blue sheep.

Lip-curl. On 3 occasions a class III male sniffed the anal area of a yearling female and then raised high his muzzle with the upper lip curled, a means of testing by olfaction whether a female is in estrus. A yearling male placed his nose into the stream of urine of a young, lip-curled, then butted the youngster in the rump.

Low-stretch. A class III male approached a yearling female from behind with his neck held low and horizontally and with his muzzle raised. His tongue flicked in and out of his mouth, and afterwards he once kicked the female. On another occasion a class IV male displayed the low-stretch to a yearling female. A gesture termed the twist, with the animal turning its head so that the horns point away from the other animal, is often given in conjunction with the low-stretch by *Ovis* and *Capra*. This display was not observed in blue sheep, but further research may reveal it.

Kick. A young moved slowly, alternately stopping and walking as it fed, closely followed by a class III male. Four times the male sniffed the spot where the young had stood. Suddenly he stepped behind the young and kicked once with each foreleg. Another instance of kicking is described above. The kicks were gentle, with the foreleg bent limply at the carpal joint and lifted no more than 15 cm off the ground ; the leg did not touch the other animal.

Inserting penis into mouth. A class III male stood at the edge of a group, slightly lowered his rump, turned his face toward the groin, and inserted his erect penis into the mouth. He kept it there some 6 to 8 seconds and seemingly sucked it. Another class III once licked his erect penis.

AGGRESSIVE BEHAVIOUR

The aggressive patterns of *Ovis* and *Capra* are in several ways distinctive. Consequently the combat methods of blue sheep can probably reveal more about the phylogenetic position of the species than other forms of behaviour. The literature is devoid of useful information on this topic except for one intriguing statement by Lydekker (1898): 'I am informed by a correspondent that, unlike domesticated rams, the male bharal [blue sheep] in the London Zoological Gardens, when charging each other, rise on their hindlegs after the manner of goats previous to the impact'. Aggression was not often seen in the wild because in a situation of potential conflict the smaller of two individuals circumvented the meeting by veering aside or feeding. When, for instance, a class III male approached a class II male at a saltlick, the latter swiftly turned 180° and grazed intensively only to return to his former place as soon as the large male departed. Those aggressive interactions that did occur can be divided into the broadside display, an indirect form of threat which may serve to intimidate an opponent by showing off certain physical attributes, and direct forms of aggression, those that either imply force or threaten the use of it.

Broadside display. An adult male sometimes halted for a few seconds on a prominent spot within the group and stood erect as if showing his fine physique to all members. However, most displays were directed at another and somewhat smaller male. Typically a male presented his broadside while walking slowly past or standing briefly by the other male. His head was slightly lowered and chin tucked in. The muzzle was often turned slightly away from the opponent, and the tail was at times raised to a horizontal or vertical position. The two animals were either parallel to each other or the displaying one presented himself at right angles. Occasionally a male deviated from his course of travel and cut in front of another one without assuming a special posture, except to walk slowly for a few steps before continuing at a normal pace. Most broadsides were displayed by class III and IV males. The behaviour elicited little response from the threatened animal which continued with its routine though it sometimes turned its head away or fed more intensively.

Horning vegetation. A blue sheep horned a low shrub with vigorous, lateral motions of its head on 6 occasions, 5 of the participants being females and one a class I male. Horning was not shown in a particular social context, and, considering the fact that females were usually involved, the behaviour may not have been a form of redirected fighting, as seems to be sometimes the case among ungulates, ‘ but a comfort activity with slight social traits ’ (Krämer 1969).

Jerk and lunge. A blue sheep often jerked down its head at another group member as if to butt. On 7 occasions the gesture was also accompanied by a lunge of a metre or more. Jerking and lunging were the most commonly observed forms of aggression (Table 1), usually shown in response to being crowded or in competition for a limited resource. An animal nearly always threatened one smaller

TABLE 1

FREQUENCY AND KIND OF OVERT AGGRESSION USED BY VARIOUS AGE AND SEX CLASSES OF BLUE SHEEP

Age and sex class	Jerk and lunge	Jump	Butt	Clash[1]	Total number aggressions	No. aggressions per animal-hour of observations
Class IV male	(1)			1	1 (1)	·03 (·50)
Class III male	6 (8)	1	1	1	9 (8)	·14 (·72)
Class II male	(2)				0 (2)	0 (·33)
Class I male	5		2	1	8 (0)	·12 (0)
Yearl. male	3 (2)	3	3 (1)	8 (1)	17 (4)	·23 (·28)
Adult female	10 (1)		(1)	2	12 (2)	·07 (·08)
Yearl. female				3 (1)	3 (1)	·05 (·08)
Young	1	1 (1)			2 (1)	·01 (·05)

Interactions at a salt lick are tabulated separately in parentheses. The data are based on 634 animal-hours of observation in a normal situation and 89 hours at a salt lick. One animal observed for one hour equals one animal-hour.

[1] Both participants in a clash are tabulated because both behaved aggressively.

than itself or one of equal size, except that yearling males sometimes jerked their head at adult females. Animals of all ages and both sexes used the jerk, but it was most often directed by class III males at yearling males and by adult females at young (Table 2). The threatened animal quickly retreated.

Table 2

Aggressors and recipients in 53 overt aggressive interactions (excluding clashes) among Blue Sheep

	Recipient							
	Male					Female		Young
Aggressor	Class IV	Class III	Class II	Class I	Yearl.	Adult	Yearl.	
Class IV male							(1)	
Class III male	1	1			5 (3)	1 (3)	(1)	(1)
Class II male							(1)	(1)
Class I male					2	4		1
Yearl. male					3	1 (1)	2 (2)	3
Adult female					1 (2)		2	7
Yearl. female								
Young								2 (1)

Interactions at a salt lick are in parentheses.

Head-shake. Once a class III male was lying down when another class III male walked up and faced him. The former tucked in his chin, then shook his head several times from side to side. This seemingly threatening gesture having no effect, he suddenly rose and lunged at the intruder.

Jump. On 6 occasions one blue sheep reared upright on its hindlegs in front of another, holding its head slightly twisted to one side as if preparing to clash horns. Twice a young jumped up before another young, once two yearling males reared up in unison, once a yearling male threatened a yearling female, and on a final occasion a class III male displayed to a class IV male but was ignored.

Butt. At times a jerk or lunge resulted in body contact—a butt or hook with the horns. The butt landed on the rump on 7 occasions and in the side once. All except one butt were delivered by males, usually by yearling and class I males, and directed mainly at females and young.

Clash. Blue sheep may clash in several ways. Sometimes two animals sparred briefly, twisting their heads while shoving and even circling rapidly with horns locked. The sheep usually faced each other, but occasionally they stood parallel with bodies almost touching as they tussled with their horns. The tail of one or both combatants may be raised vertically. In such a position, the white hairs at the edge of the tail seem to fan out, making the rump area quite conspicuous. At other times an animal may rear up, take a hop or two on its hindlegs, then lunge at another who merely catches the horn blow with its horns. Occasionally both sheep faced each other, perhaps first taking a few steps backwards, then rearing up on the hindlegs to stand with muzzles twisted sideways and with forelegs either hanging loosely or sharply flexed at the carpal joints. After a moment of hesitation they fell forward in unison to clash horns while their forelegs were still off the ground. Contact may then continue in the form of a brief sparring match. In a variation of this combat method, two animals stood side by side while facing in opposite directions with their shoulders almost touching. Sometimes they circled rapidly before suddenly standing up and, with horns cocked toward each other, plunging sideways to meet with a crash. Immediately both may rear up once more and clash, again and again, as many as 11 times in quick succession. Finally one animal terminates the interaction by turning away, and it may then be lunged at or butted. Yearling males clashed most often, usually with other yearling males or with yearling females ; class II, III, and IV males were not involved in clashing, except once when two adults touched horns.

Table 1 lists only 9 instances of clashing, and of these 4 were gentle sparring bouts. But, in addition, I witnessed one general melee lasting 5 minutes during which several animals butted, clashed, and chased each other. The aggressive interactions in this incident were not quantified, and hence not included in Tables 1 and 2, because I was unable to record them all. Partners changed often and sometimes the action moved out of sight behind rock outcrops. There were 15 sheep including 2 class III and a class IV male, in the group that day, but only 3 adult females, 2 yearling females, and 2 yearling males took part in the general fighting which ensued after an adult female and a yearling male clashed. Two vignettes from this lengthy incident are described below :—

(1) A yearling female watched two yearling males first stand on their hindlegs and clash, then tussle on all fours with horns locked. Suddenly she lunged in and butted a male in the rump. He twisted around and sparred with her briefly. As he turned again to face his original partner, the latter reared up quickly and lunged, and he had barely time to catch the blow on his horns.

(2) Several animals trotted around in a compact group when a yearling female, slightly ahead of the others, suddenly turned and reared up in front of the others. These shied aside, and, in turning, one yearling female clashed with a yearling male behind her. She then butted him in the side. A nearby adult female joined the fray, lunging

at the male who returned the attack by crashing his horns against hers.

Table 1 shows that frequency of aggression varied considerably between the age and sex classes. In this table, and in Table 2, I have quantified aggression at a saltlick separately from other circumstances. At the saltlick, which I established and which blue sheep visited on 3 days, the animals were artificially crowded and competed for the salt. This affected their behaviour. Females and young were quite unaggressive. The males, especially the males of classes II and IV, also interacted with a low frequency during their daily routine. But aggression in class II, III, and IV males increased markedly at the saltlick where a large male characteristically appropriated a choice spot and threatened any smaller animal which approached. Yearling males had the highest aggressive rating away from the saltlick and a moderately high one at it.

Discussion

My enumeration of courtship and aggressive displays in blue sheep is undoubtedly incomplete. However, enough of a repertoire was witnessed to make comparisons between *Pseudois*, *Ovis*, and *Capra* instructive. Turning first to courtship patterns, the lip-curl and low-stretch are so widespread among ungulates that their presence in blue sheep was to be expected. Both *Ovis* and *Capra* use the kick, the former a high vigorous one (Geist 1971) and the latter generally a weak one with the foreleg somewhat bent (Walther 1961). Blue sheep kick more like goats than sheep. The males of several species of *Capra* and *Ammotragus* may place their penis into the mouth (Hass 1958 ; Schaller & Mirza, in press), a behaviour also observed in blue sheep. A similar pattern has not been reported for *Ovis*. A courting *Ovis* male usually does not raise his tail much above the horizontal whereas a *Capra* male may arch it up on the rump. Blue sheep differ from both these genera in that they raise the tail straight up, a position also observed in courting Himalayan tahr (*Hemitragus jemlahicus*) by Schaller (in press).

A broadside display with chin tucked in is found in markhor (*Capra falconeri*) and Marco Polo sheep (*Ovis ammon polii*) ; and head-shaking as a form of threat occurs in ibex (*Capra ibex*) and Marco Polo sheep (Walther 1961). The jerk, lunge, and butt, as well as the tendency to horn vegetation, can be observed in many ungulates. The presence of these behaviour patterns in blue sheep does thus little to clarify the evolutionary affinities of that species.

Both *Ovis* and *Capra* may rear up on their hindlegs, the sheep standing with body not quite erect and with forelegs extended, and true goats wholly upright with forelegs flexed. Blue sheep jump up like goats. Many horned ungulates, including all Caprini, may fight by sparring with their horns, but some differences exist in the way *Ovis* and *Capra* clash. Some sheep, such as the urial (*Ovis orientalis*), may run at each other on all fours from a distance of 5 m or more and then crash together with tremendous impact (Schaller & Mirza, in press). Other sheep, such as mountain sheep (*Ovis canadensis*), may rear up and race at each other on their hindlegs before lunging downward to clash (Geist 1971). True goats, on the other hand, tend to stand bolt upright and then plunge forward or sideways against the horns of an opponent, the two animals sometimes meeting before their forelegs touch the ground. Blue sheep clash like *Capra*, as Lydekker (1898) intimated many years ago.

Ovis and *Capra* males may use the low-stretch and kick in quite different contexts. True goats display these patterns usually towards females, whereas sheep low-stretch and kick not only when courting but also when expressing their dominance to other males. The fact that I did not observe blue sheep males direct these displays at each other is suggestive. A behaviour pattern of sheep but apparently not of true goats is the huddle. Several males may cluster, heads facing inward, and indescriminately clash, kick, and nuzzle each other. The huddle was not observed in blue sheep.

Many aspects of the behaviour of blue sheep remain unknown. It would, for example, be of interest to study the rut of this species, something I plan to do soon. Do adult blue sheep males tend to attach themselves to a particular group of females during the rut in the manner of some goats, or do they roam from herd to herd in search of estrous females as is characteristic of sheep? Whatever the social organization of blue sheep, the behaviour patterns as observed during this study provide the best clues to the taxonomic affinities of the species. In certain ways of courting and in several forms of aggression, particularly in the method of clashing, blue sheep behave like *Capra* rather than *Ovis*. Behavioural data thus support the morphological evidence that blue sheep are closely allied to the goats. The distinctive generic designation for this somewhat aberrant species is perhaps justified, but there is no question that the popular English name should be changed from blue sheep to blue goat.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—13

Alcedinidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **69** (2) : 389]

717 **Ceryle lugubris continentalis** Hartert (Sikkim) West Himalayan Pied Kingfisher **4** : 248

13 : 4 ♂♂ 7 ♀♀ 2 o?

5 Simla Hills ; 1 Ramgarh, 2 Almora, U.P. ; 1 Coffeebari, Darjeeling ; 2 Kurseong, 1 Teesta River, Singtam, Sikkim ; 1 no data.

	Wing	Bill	Tarsus	Tail
♂♂	180, 182, 183(2)	63, 65(2), 70	14(3), 15	102, 106, 107, 112
	(IH 177-186	from skull 68-80	12-14	103-114)
♀♀	180-187 av. 184	65-72 av. 67	14-15	105-112 av. 108.5
	(IH 178-195	from skull 69-75	13-15	98-112)

Sikkim is an unfortunate type locality for a ' West Himalayan ' form !

718 **Ceryle lugubris guttulata** Stejneger (Ningpo, China) East Himalayan Pied Kingfisher **4** : 248

1 ♂ Tezu, Lohit Valley, Assam.

Wing 187 ; bill 72 ; tarsus 15 ; tail 114.

The single specimen, together with two yet unregistered females from Central Bhutan, are more grey and slightly darker on the upperparts. One of the two from Bhutan marked ' ♀+ ' lacks the rufous underwing found in females of both races.

EL **Ceryle rudis rudis** (Linnaeus) (Egypt) Western Small Pied Kingfisher

4 : 2 ♂♂ (by plumage) 2 ♀♀

1 *Suleimaniyah*, 1 *Kurna, Tigris*, 1 *Basra, Iraq* ; 1 *Bikraz, Persian Gulf.*

	Wing	Bill	Tarsus	Tail
♂♀	142-147	58-61	10-11	79, 80, 81(2)

In addition to being larger than *leucomelanura*, this race has black spots on the white basal half of the tail, contra all-white. The basal portion of the outer web of the 3rd primary is also black with two white spots instead of all-white.

719 **Ceryle rudis leucomelanura** Reichenbach (Ceylon) Indian Pied Kingfisher 4 : 246

26 : 14 ♂♂ (2 by plumage) 12 ♀♀ (2 by plumage).

2 Chakala, Rawalpindi ; 1 Lahore, 2 Meerut ; 1 Dadu, Larkana, Sind ; 1 Marval, Rajputana ; 1 Cutch, 1 Deesa, Palanpur, 1 Saiat, Kaira, 1 Gir Forest ; 1 Khamgaon, Dhond, 1 Satara ; 1 Naiti-Saran (T. R. Bell 1901 = N. Kanara ?) ; 1 Koduru, S. Cuddapah ; 1 Saugor, M.P. ; 1 Barkul, Chilka Lake, Orissa ; 1 Rajputtee, 4 Tirhut, Bihar ; 1 Roopchena, Cachar, 1 Dibrugarh ; 2 *Myogwin, Henzada, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	130-141 av. 136	56-64	10-11	61-73
	(IH 133-142	from skull 66-68	10-12	66-70)
♀♀	135-143 av. 139	60-63	9-10	67-73
	(IH 139-141	from skull 61-70	10-13	65-75)

There is considerable variation in the amount of black or white visible on the head and upper plumage, partly due to the preparation of the skin. No. 11241, a ♀ from Dibrugarh, Assam, is very black above and shows little or no white.

720 **Ceryle rudis travancoreensis** Whistler & Kinnear (Travancore) Kerala Pied Kingfisher

nil.

721 **Alcedo hercules** Laubmann (Darjeeling) Blyth's or Great Blue Kingfisher 4 : 258

nil.

Alcedo atthis

Three subspecies, *pallasii*, *bengalensis*, and *taprobana* are accepted from Indian limits in IND. HANDBOOK as in Stuart Baker's FAUNA. Birds from the same area differ in colour, presumably by age, and the differences in size are barely visible in series, making it very difficult to trinomially name most of the specimens.

The bird is said to be migratory, but nothing is known of its movements in India, and it is quite possible as suggested by Ticehurst (*Ibis* 1923 : 32) that more than one race occurs in the same area.

In all three groups the juveniles have their underparts very pale whitish rufous, with patches of pure white on the belly, but this does not appear to be referred to in the literature available. Some in later (?) plumage show grey or bluish edges to the feathers of the upper breast and, until the adult plumage with completely rufous underparts (excluding the white chin) is attained, the upper parts are paler tending towards those of *pallasii* (a).

The few which definitely appear to be *pallasii* and *taprobana* have been grouped together under sub-headings (a) and other specimens from the same area, which could well be included with *bengalensis*, are placed with them under sub-heading (b).

722 **Alcedo atthis pallasii** Reichenbach (Siberia) Central Asian Small Blue Kingfisher 4 : 253

22 : 9 ♂♂ 10 ♀♀ 3 o ?

(a) 11 : 4 ♂♂ 5 ♀♀ 2 o ? (1 juv.)

1 *Lake Akkakurf, nr. Baghdad,* 1 *Basra, Iraq*; 1 *Mishun, Persian Gulf*; 1 *Bander-e-Gaz, Asterabad,* 2 *Pir-i-Bam, Shiraz,* 1 *Sib, Iran*; 1 Hajarganji, 27·28°N-65·10°E, Baluchistan ; 1 Wana, Waziristan ; 1 Jajja Abbasian, Bahawalpur ; 1 *Kashgar.*

(b) 11 : 5 ♂♂ 5 ♀♀ 1 o ?

1 Jabli, Bhagat State, 1 Gama-ki-Hatti, Dharmi State, 2 Simla ; 1 Madhopur, 1 Machiasen, Ludhiana ; 2 Jagadhri, Ambala ; 2 Delhi ; 1 Bageshwar, Almora, U.P.

Group (a) has pale upperparts and the two from Iraq are marked *pallasii* by Ticehurst (?) and are so listed in the report on the Birds of Mesopotamia (*JBNHS* **28** : 302).

Group (b) is not different from *bengalensis* in color and is only slightly larger in series :

	Wing	Bill	Tarsus	Tail
Group (a) ♂♀	72-76 av. 73·4	35-43 av. 38·3	9-10	30-36 av. 33
Group (b) ♂♀	70-76 av. 73	35-40 av. 37·6	9-10	30-35 av. 32·3
	(IH ♂♀ 71-77	—	9-11	31-36)
bengalensis ♂♀	67-74 av. 71·7	35-41 av. 36	9	29-36 av. 32
	(IH ♂♀ 68-74	—	8-10	30-37)
taprobana (a) ♂♀	69-74 av. 71·5	35-38 av. 35·8	9	30-34 av. 31·7
taprobana (b) ♂♀	69, 70, 74	34, 35, 37	9(3)	30, 31(2)
	(IH ♂♀ 67-73	—	8-9	29-33)

723 **Alcedo atthis bengalensis** Gmelin (Bengal) Indian Small Blue Kingfisher 4 : 250

35 : 16 ♂♂ 14 ♀♀ 5 o ?

1 Hamavas Lake, Pali Dt., Rajasthan ; 1 Balaram, Palanpur, Gujarat, 2 Ganges Canal, Aligarh ; 1 Sanchi, Bhopal State, 1 Chikalda, Berar ; 1 Bhopalpatnam-Bastar, 1 Gondia, 1 Central Provinces ; 1 Barkul, Chilka Lake, 1 Mahendra, giri ; 3 Baghowni, Bihar ; 1 Bhuguwda, Nepal ; 1 Buxa Duars, 1 Kurseong, 1 Longview Tea Estate, Darjeeling ; 1 Seooki, Tista Valley, Sikkim ; 1 Dibrugarh, 2 Margherita, 1 Tezu, Lohit Valley, 1 Laising 2 N. Cachar, Assam ; 3 South Andamans ; 1 Car Nicobar ; 2 Camorta, Central Nicobars ; 1 Campbell Bay, Great Nicobars ; 1 *Toga Chaung, Thayetmyo Dt.* ; 2 *Prome Dt., Burma* ; 1 no data.

The measurements are under 722. As explained earlier several in *pallasii* and *taprobana* are hardly separable from *bengalensis.*

The specimens from M.P. and Orissa are *slightly* darker above, showing a similarity to *taprobana.*

724 **Alcedo atthis taprobana** Kleinschmidt (Ceylon) Ceylon Small Blue Kingfisher 4 : 252

9 : 4 ♂♂ 2 ♀♀ 3 o?

(a) 6 : 4 ♂♂ 1 ♀ 1 o?

1 Saiat, Kaira, 1 Dhari, Amreli ; 1 Karwar, N. Kanara ; 2 Nilambur Valley, 1 Tenmalai, S. Travancore.

The birds from Gujarat are dated 12 December and 20 January, while the two from Nilambur Valley are the richest in colour, both above and below.

(b) 3 : 1 ♀ 2 o?

1 Uran, Bombay ; 1 Karwar, N. Kanara ; 1 Cumbum Valley.

These may be included with *bengalensis*, but the Karwar bird (No. 11276) has a 34 mm bill and *may* be immature *taprobana.* In Eastern Ghats Report (*JBNHS* **37** : 760) Whistler said with reference to the Cumbum Valley specimen and other specimens from the Madras Presidency : ' All the specimens which I have examined from the Presidency, south of the Godavery River, most certainly belong to the very blue Cinghalese race and not to *Alcedo a. bengalensis.*'

725 **Alcedo meninting coltarti** Baker (Saddya, Assam) Assam Blue-eared Kingfisher 4 : 256

6 : 2 ♂♂ (juv.) 2 ♀♀ 2 o?

1 Dhurdhura Chamba, Simlipal Hills, Orissa ; 1 Gama Res., Goalpara, 1 Goalpara, 1 Margherita, 1 Assam ; 1 *Ataran, Burma.*

	Wing	Bill	Tarsus	Tail
♂♀	66-70 av. 68	37-40 (4 only)	7	27-30 av. 28.3
	(IH 62-74	from skull 43-45	*c.* 9	28-30)

Two birds from the Andamans under *rufigaster* (726a) are separable but I have already (*JBNHS* **64** : 174) indicated that examination of a larger series at the British Museum did not appear to justify this separation. If so, Walden's *rufigaster* is an older name.

726 **Alcedo meninting phillipsi** Baker (Cocoawatte Estate, Ceylon) Ceylon Blue-eared Kingfisher 4 : 255

1 o? Wing 64 ; bill 40 ; tarsus 8 ; tail 27.

The forehead does not show a greenish tinge.

726a **Alcedo meninting rufigaster** Walden (South Andaman Island) Andaman Blue-eared Kingfisher 4 : 257

2 ♂♂ 1 Long Island, Middle Andamans ; 1 Shoalbay Creek, South Andaman.

	Wing	Bill	Tarsus	Tail
	65, 68	—, 40	8, 9	27, 30
(♂♀	IH 63-71	—	—	27-30)

See remarks under 725

727 **Ceyx erithacus erithacus** (Linnaeus) (Benghala) Indian Threetoed Forest Kingfisher 4 : 226

10 : 5 ♂♂ 3 ♀♀ 2 o ?

1 Bandra, 1 Dadar, 2 Bombay City ; 1 Kadra, 1 Sunksal, 1 Gersoppa, N. Kanara ; 1 Point Calimere, Tamil Nadu ; 1 Goalpara, 1 Cachar, Assam.

	Wing	Bill	Tarsus	Tail
♂♀	54-60 av. 57	31-34 av. 32.5	8-9	22-29
	(IH 53-61	from skull 32-37	c. 7-8	21-24)

Except for one obtained at Gersoppa on 24 April, all the others were taken between 13 May (Assam) and ? October (Point Calimere). Two of the three from N. Kanara have more lilac on the head than the others.

728 **Ceyx erithacus macrocarus** Oberholser (Great Nicobar) Nicobar Threetoed Forest Kingfisher 4 : 262

1 o ? Campbell Bay, Great Nicobar.

As indicated in my Nicobar report (*JBNHS* **64** : 174), I am unable to separate this and several others examined, from both the Andaman and Nicobar Islands, from the nominate form.

728a **Ceyx erithacus rufidorsus** Strickland (Malacca).

1 o ? Sikkim Terai. 22 July 1909.

(See Abdulali, *JBNHS* **61** : 439).

729 **Pelargopsis amauroptera** (Pearson) (Calcutta) Brownwinged Storkbilled Kingfisher 4 : 263

nil.

730 **Pelargopsis capensis capensis** (Linnaeus) (Chandernagor, Bengal) Brownheaded Storkbilled Kingfisher 4 : 265

25 : 11 ♂♂ 7 ♀♀ 7 o ?

1 Balaram, Palanpur, 1 Dediapada, Rajpipla, 1 Waghai, Surat Dangs, Gujarat ; 1 Pili, Melghat, 2 Kolkaz, Berar ; 1 Bijiwar, Indore ; 1 Central Province ; 1 Jalavi (T. R. Bell=Karwar), 1 Kala Nadi, Kanara ; 1 Balghar, Puri, 1 Narmada Lake, Champaner, Orissa ; 1 Baghowni, 1 Madhubani, 1 Anarh, Darbhanga, 1 Rajputtee, Saran, Bihar ; 1 Bhimtal, 1 Nainital, Kumaon, 1 Pilibhit, 1 Longview T.E., Darjeeling, 1 Kurseong ; 1 Camp Pishnu, 1 Goalpara, 1 Margherita, Assam ; 1 no data.

	Wing	Bill	Tarsus	Tail
♂♂	154-160 av. 157	79-90 av. 86	17-19	94-106 av. 100
	(IH 147-163	from skull 84-93	17-20	94-110)
♀♀	148-162 av. 156	74-89 av. 82	17-18	97-105 av. 99.8
	(IH 155-168	from skull 86-94	17-20	95-105)

In series the central and west Indian birds have slightly darker heads and upperparts than those from the east. There is no appreciable difference in size.

731a **Pelargopsis capensis osmastoni** (Baker) (Andaman Islands) Andaman Storkbilled Kingfisher

2 ♀♀ : 1 Long Island, Middle Andamans ; 1 Chirria Tapoo, South Andamans.
Wing 147, 157 ; bill 86, 87 ; tarsus 17, 18 ; tail 94, 98.

732 **Pelargopsis capensis intermedia** Hume (Galatea Bay, Great Nicobar Island) Nicobar Storkbilled Kingfisher 4 : 264

1 ♀ Campbell Bay, Great Nicobar.
Wing 152 ; bill 85 ; tarsus 18 ; tail 100.

EL **Pelargopsis capensis burmanica** Sharpe (Taunghoo, Burma) Burmese Storkbilled Kingfisher 4 : 266

3 : 1 ♂ 1 ♀ 1 o?
1 *Kuzaik, Lower Chindwin* ; 1 *Taungyi, S. Shan States* ; 1 *Pankai, Prome Dist., Burma.*

Wing	Bill	Tarsus	Tail
155, 159, 162	81, 86(2)	16, 17(2)	100, 107, 109
(146-165	72-84	—	—)

733 **Halcyon coromanda coromanda** (Latham) (Coromandel, India) Indian Ruddy Kingfisher 4 : 273

2 o ? : 1 *Pyaungaung, N. Shan States*, 1 *Arakan Yoma, Burma*

Wing	Bill	Tarsus	Tail
121, —	55, 61	16, 16	66, —
(IH 106-121	from skull 60-63	18, 19	60-71)

734 **Halcyon coromanda mizorhina** (Oberholser) (North Andaman Island) Andaman Ruddy Kingfisher 4 : 274

nil.

Halcyon smyrnensis

As in *Alcedo atthis* the three subspecies accepted for continental Indian limits i.e. *smyrnensis*, *fusca*, and *perpulchra* cannot be separated with any degree of certainty. Three young birds, all from the range of *smyrnensis*, are duller and greenish blue above, but we have been unable to associate any of the differences in shades of blue and greenish with stages of wear, age, sex, or season. Unlike *A. atthis*, there is no evidence of migration [though suggested in BIRDS OF THE SOVIET UNION (1 : 583)] and I have grouped them in accordance with the distribution in IND. HANDBOOK.

735 **Halcyon smyrnensis smyrnensis** (Linnaeus) (Smyrna) Whitebreasted Kingfisher 4 : 268

24 : 12 ♂♂ (3 juv.) 6 ♀♀ 6 o?

1 *Sulaimanyah*, 1 *Kazimain*, 1 *Lake Akkarkuf, nr. Baghdad, Iraq* ; 1 *Bikarz Castle*, 1 *Pir-i-Bam, 9 m. s. of Shiraz, Persia* ; 1 *Mand*, 1 *Putak, Quasarqund, Persian Baluchistan*, 1 Giyan, Kalat, 1 Karung ; 1 Keonthal State, 1 Lahore, 1 Maharikpur, 1 Guggar, Ambala ; 1 Simla, 3 Delhi, 1 Jumpier, Sind ; 1 Vaghjipur, Mehsana, 1 Gir Forest, 1 Cambay City, 1 Bodeli, Baroda; 1 Mussoorie, 1 Kumaon, U.P.

	Wing	Bill	Tarsus	Tail
♂♂	116-125 av. 121	55-64 av. 61·5	14-16	80-85 av. 82
♀♀	116-135 av. 123·5	60-65 av. 61·5	14-16	78-87 av. 83
	(IH 118-128	from skull 60-67	16-19	77-93)

♀ 11348 from Putak, Quasarqund, Persian Baluchistan, has a 135 mm wing (the next largest is 128 mm), bill 65 cf. 64 in ♂, and tail 87, equalled in another ♀ from Guggar, Ambala.

fusca ♂♂	118-124 av. 120·6	56-62 av. 59·5	14-16	76-83 av. 80
fusca ♀♀	120(2), 124, 125	55, 58, 59(2)	14,15(3)	78, 79, 83, 85
	(IH 113-124	from skull 56-63	15-16	72-83)
perpulchra ♂♂	118-126 av. 121	60-66 av. 62	15-16	76-84 av. 80
♀♀	117-124 av. 121	53-64 av. 59	14-16	74-84 av. 80

(IH : ' within the range of *fusca* but somewhat on the smaller side.')

736 **Halcyon smyrnensis fusca** (Boddaert) (Malabar Coast) Indian Whitebreasted Kingfisher 4 : 269 (part)

18 : 9 ♂♂ 4 ♀♀ 5 o?

2 Bharatpur, Rajasthan ; 2 Kurla, Thana, 1 Bombay, 1 Satara, 1 Vengurla, 1 Ratnagiri, Maharashtra; 1 Potoli, 1 Karwar, Kanara; 1 Nelliampathy Hills, 1 Perumalmalai, Palnis ; 1 Perren Godda, S. Travancore ; 1 Kanyakumari; 1 Koduru, Cuddapah; 1 Bina, C.P.; 1 Bulandshahr, U.P.; 1 Navalpur, Nepal.

Measurements are under 735.

Two unsexed birds Nos. 11352 from Perren Godda (collected by J. P. Cook, probably in Travancore) and 20718 from Perumalmalai, Palnis, have darker chocolate-brown heads and underparts, characters shared with a ♂ (No. 18862) from Badrama, Bamra, Orissa, listed under *H. s. perpulchra.*

737 **Halcyon smyrnensis perpulchra** Madarász (Singapore) Eastern Whitebreasted Kingfisher 4 : 269 (part)

17 : 7 ♂♂ 8 ♀♀ 2 o?

1 Sonawani, Balaghat ;1 Chilka Lake, 1 Khandpara, 1 Badrama, Bamra, 1 Harbhanga Bund, Orissa ; 2 Baghowni, Tirhut, 1 Hazaria, Patherghatta, Bihar ; 1 Mornai T.E., Goalpara, 1 Dibrugarh, Assam; 1 *Mala*, 1 *Kani*, 1 *Singhalia*,

Chindwin ; 1 *Taunggyi, S. Shan States,* 2 *Temyak Chang Thayetmyo,* 1 *Prome Dt., Burma.*

The measurements are under 735.

738 **Halcyon smyrnensis saturatior** Hume (Andaman Islands) Andaman Whitebreasted Kingfisher 4 : 270

3 : 1 ♂ 2 ♀♀
1 Ferrarganj, 2 Wimberleyganj, S. Andamans.

	Wing	Bill	Tarsus	Tail
♂	131	68	15	87
♀♀	127, 130	62, 67	15, 15	82, 82

The blue on the upperparts is of a different tint in each of the three, but two of them, a ♂ and a ♀, are definitely brighter than any of the other specimens of this species. The brown of the head and underparts is also darker and almost black. All three can be separated from the birds from continental India, both by colour and size.

739 **Halcyon pileata** (Boddaert) (China) Blackcapped Kingfisher 4 : 271

13 : 7 ♂♂ 5 ♀♀ 1 o ?
1 Ghana Sanctuary, Bharatpur ; 1 Sakalpatal, Surat Dangs ; 1 Kalyan, 1 Thana Creek, 1 Colaba, Bombay ; 2 Karwar, N. Kanara ; 4 Tirhut, Bihar ; 1 Narcondam I., Andamans ; 1 Trinkut, Central Nicobars.

Several have the breast feathers slightly flecked with black, a sign of immaturity. There is considerable variation in the extent of white and rufous on the underparts.

	Wing	Bill	Tarsus	Tail
♂♂	129-133 av. 130	61-65 av. 62·5	15-16	78-84 av. 82
♀♀	123-130 av. 127·5	62-68 av. 64·5	15	78-84 av. 81
	(♂♀ 127-133	57-65	*c.* 15	83-88)

740 **Halcyon chloris vidali** Sharpe (Ratnagiri and Kelsi Creek, Konkan) Malabar Whitecollared Kingfisher 4 : 276

1 o ? Ratnagiri, Maharashtra.
Wing 112 (110-116) ; bill 46 (42-49) ; tarsus 15 (*c.* 16) ; tail 70 (70-73).

This was collected by G. W. Vidal on 1st February, 1878 and is one of our oldest specimens.

741 **Halcyon chloris humii** Sharpe (Siam to the Malay Peninsula and Sumatra ; type from Jaram, Selangor, Malay Peninsula) Eastern Whitecollared Kingfisher 4 : 275

nil.

742 **Halcyon chloris davisoni** Sharpe (Aberdeen, S. Andamans) Andaman Whitecollared Kingfisher 4 : 278

3 : 1 ♂ 2 ♀♀
2 Bakultala, Middle Andamans ; 1 Shoalbay Creek, S. Andamans.

Wing	Bill	Tarsus	Tail
101♂, 105, 108	43, 44, 47♂	13, 14, 14	61♂, 69, 73
(IH ♂♀ 96-108	38-41	c. 14-15	63-72)

743 **Halcyon chloris occipitalis** (Blyth) (Central Nicobars) Nicobar Whitecollared Kingfisher 4 : 277 (part)

9 : 3 ♂♂ 5 ♀♀ 1 o?
5 Camorta, 3 Nancowry, 1 Trinkut, Central Nicobars.

	Wing	Bill	Tarsus	Tail
♂♀	106-112 av. 108	43-48 av. 46	13-15	71-80 av. 73
	(105-113	40-48	14-15	65-72)

Juvenile ♂ No. 22469 from Nancowry is paler blue than the adults and resembles birds from Car Nicobar.

743a **Halcyon chloris** subsp. Car Nicobar Whitecollared Kingfisher 4 : 277 (part)

7 : 3 ♂♂ 4 ♀♀ Car Nicobar

	Wing	Bill	Tarsus	Tail
♂♀	104-117 av. 109·7	42-46 av. 45	13-15	70-80 av. 73

In my Narcondam note (*JBNHS* **68** : 405) I have referred to the distinctness of this group from the other forms available and to my inability to name it due to lack of information regarding the 47 subspecies accepted in Peter's CHECKLIST.

(*to be continued*)

Contribution to the flora of Tirap Frontier Division

BY

D. B. DEB AND R. M. DUTTA

[*Continued from Vol.* **68** (3) : 595]

STYRACACEAE

Styrax serrulatum Roxb.

Shrub or small tree with whitish or mauve-coloured flowers and fruits covered with brownish green tomentum ; fairly common. Pungchow, July 1961, *Deb* 26568 ; Chenglang, March 1958, *Murthy* 12986 ; Lailongsong, 510 m., June 1961, *Deb* 25797.

CORNACEAE

Aucuba himalaica Hook. f. et Thoms.

A medium-sized tree in flowers and fruits ; scattered in the subtropical forest. Chennhang, June 1961, *Deb* 26238 ; Noglo, June 1961, *Deb* 26339.

Cornus alternifolia L. f.

A small tree in fruits ; scarce. Noglo, June 1961, *Deb* 26350.

ALANGIACEAE

Alangium barbatum (R. Br.) Bail. ex Kuntze

Shrub or a small tree ; flowers white ; fruits bluish when ripe ; scarce. Noglo, June 1961, *Deb* 26348 ; Banfera, July 1961, *Deb* 26738.

A. chinense (Lour.) Harms.

Bushy shrub with white flowers ; fairly abundant and common. Chenglang, Aug. 1958, *Panigrahi* 14425 ; Khonsa, June 1961, *Deb* 25858 ; Chennhang, June 1961, *Deb* 26182 ; Lailongsong, 510 m., June 1961, *Deb* 25793.

NYSSACEAE

Nyssa javanica (Bl.) Wang.

A large tree in flowers and fruits; scattered. Jadua, July 1961, *Deb* 26683.

ARALIACEAE

Aralia armata (Wall. ex G. Don) Seem.

Shrub or small tree with whitish flowers; scattered. Pangsupass, Oct. 1959, *Rao* 20021.

A. thomsonii Seem.

Shrub or small tree in flowers and fruits; scattered. Lailongsong, 510 m., June 1961, *Deb* 25840; Wakka-Ngminu, July 1961, *Deb* 26531.

Brassaiopsis glomerulata (Bl.) Regel

Shrub or small tree in flowers and fruits; scarce. Noglo, June 1961, *Deb* 26342; Wakka, July 1961, *Deb* 26432.

B. glomerulata (Bl.) Regel var. **serrata** Mahesw.

Small tree; rare. Wakka, July 1961, *Deb* 26412.

B. hainla (Ham. ex D. Don) Seem.

A small prickly tree in flowers and fruits; common. Chennhang, June 1961, *Deb* 26222; Langsang forest, June 1961, *Deb* 26118.

Merrilliopanax listeri (King) Li.

Shrub with small white flowers; rare. Noglo, June 1961, *Deb* 26329 & 26345.

Panax pseudo-ginseng Wall.

An undershrub in humid situations. In flowers and fruits; fairly common. This is very variable in habit. Wakka, July 1961, *Deb* 26395; Chegum, July 1961, *Deb* 26479.

Schefflera venulosa (Wt. & Arn.) Harms.

An epiphytic scandent shrub or a climber; flowering; fairly common. Langsang, June 1961, *Deb* 26117; Chegum, July 1961, *Deb* 26484; Chennhang, June 1961, *Deb* 26273; Wakka, July 1961, *Deb* 26440; Khonsa, June 1961, *Deb* 25946.

CAPRIFOLIACEAE

Carlemannia griffithii Benth.

Herb; flowers small, white or pinkish; fairly common. Pungchow, July 1961, *Deb* 26580 ; Pangsupass, Oct. 1959, *Rao* 20067.

Lonicera braciana Hemsl.

A climber with showy yellow flowers ; rare. It is worthy of consideration for introduction as an ornamental plant. Wakka, July 1961, *Deb* 26392.

L. macrantha (D. Don) Spreng.

A climber with white and yellow flowers on the same branch ; rare. Chennhang, June 1961, *Deb* 26277.

Sambucus hookeri Rehder.

Shrub or small tree, flowers white ; fairly common. Kothong, June 1961, *Deb* 26078 ; Jangkeng village, June 1961, *Deb* 25871.

Silvianthus bracteatus Hook. f.

Undershrub with weak stem in fruit ; scarce. Pangsupass, Oct. 1959, *Rao* 20006 ; Lailongsong, 510 m., June 1961, *Deb* 25814 ; Pungchow, July 1961, *Deb* 26624.

Viburnum colebrookianum Wall.

A shrub or small tree with white flowers ; common. Chenglang, March 1958, *Murthy* 12906 ; Tipang, June 1961, *Deb* 25713.

V. coriaceum Bl.

A shrub or small tree with bluish to white flowers ; fairly common. Chennhang, June 1961, *Deb* 26243.

V. odoratissimum Ker

A shrub or a small tree in flowers ; rare. Noglo, June 1961, *Deb* 26341 ; Khonsa, June 1961, *Deb* 25968.

V. simonsii Hook. f. & Thoms.

A bushy shrub or small tree in flower ; scarce. Noglo, June 1961, *Deb* 26340 & 26350 ; Wakka, July 1961, *Deb* 26486.

V. mullaha Ham. var. **glabrescens** C. B. Clarke

A climber, scarce. Wakka, July 1961, *Deb* 26493.

BUXACEAE

Sarcococca saligna (D. Don) Muell.-Arg.

A shrub growing in a community ; scarce. Chennhang, June 1961, *Deb* 26236.

BETULACEAE

Alnus nepalensis D. Don

A large tree. Natural regeneration is common, Laju hills, Aug. 1958, *Panigrahi* 14666 ; Kothong, June 1961, *Deb* 26031.

Betula alnoides Buch.-Ham. ex D. Don

A medium-sized tree ; scarce. Bark is used by the local people as a substitute for paper. Khela, June 1961, *Deb* 25938.

FAGACEAE

Castanopsis griffithii King

A medium sized tree ; rare. Oct. 1959, *Rao*, S.N.

C. indica (Roxb.) A. DC.

A medium-sized tree in creamy white flowers ; scarce. Soha village, 1067 m., Oct. 1959, *Rao* 20375.

C. tribuloides A. DC.

A medium-sized tree ; scarce. Tinchha, Aug. 1958, *Panigrahi* 14657.

Lithocarpus dealbata (Hook.f. & Th. ex A. DC.) Rehder

Pasania dealbata (Hook.f. & Th.) Oerst.

A small tree ; scarce. Niausa-Wanu, Sept. 1958, *Panigrahi* 15002.

L. fenestrata (Roxb.) Rehder.

Pasania fenestratus (Sm.) Oerst.

A large tree ; common. Chennhang, June 1961, *Deb* 26233.

L. spicata (Sm.) Rehder. & E. H. Wils.

Pasania spicata (Smith) Chatterjee

A small tree in flower ; rare. Lailongsong, 510 m., June 1961, *Deb* 25773.

Quercus lanceaefolia Roxb.

A large tree ; fairly common ; one of the dominant trees in the forest ; Lunwa, July 1961, *Deb* 26638.

CORYLACEAE

Carpinus viminea Wall. ex Lindl.

A medium-sized tree in flower ; common in places. Pangchow, July 1961, *Deb* 26609.

ULMACEAE

Celtis cinnamomea Lindl.

A small tree, in fruit. Khonsa, June 1961, *Deb* 25966.

Trema orientalis (L.) Bl.

A tree ; fairly common. Khonsa-Laju, June 1961, *Deb* 25996.

MORACEAE

Artocarpus lakoocha Roxb.

A very small tree about 30-40 m. in height ; scarce. Namchik, 152 m., Oct. 1959, *Rao* 20190.

Ficus auriculata Lour.

A shrub or a tree in fruits ; sometimes epiphytic ; common. Khela, March 1958, *Murthy* 12973 ; Wakka, Aug. 1958, *Panigrahi* 14814 ; Laju-Raho, Aug. 1958, *Panigrahi* 14763 ; Chenglang, Oct. 1959, *Rao* 20225 ; Kothong, June 1961, *Deb* 26040.

F. bengalensis Linn.

A large tree in fruit. Jadua-Banfera, July 1961, *Deb* 26664.

F. subincisa J. E. Smith

F. clavata Wall. ex Miq.

A small tree in fruit ; fairly common. Longseck hillock, June 1961, *Deb* 25727 ; Jadua, July 1961, *Deb* 26675 ; Chennhang, June 1961, *Deb* 26210.

F. cyrtophylla Wall. ex Miq.

A shrub or a small tree ; fruits red or brown when ripe ; fairly common. July 1961, *Deb* 26279 ; Lailongsong, 510 m, June 1961, *Deb* 255776 ; Jadua, July 1961, *Deb* 26657 ; Kothong, June 1961, *Deb* 26041.

F. fistulosa Reinw.

A shrub in fruit ; fairly common. Chenglang, March 1958, *Murthy* 12916.

F. pubigera Wall. ex Miq. var. **malliformis** (King) Corner

A shrub or a small tree. Hypanthium greenish or brownish yellow, lenticular ; fairly common. Namchick, Oct. 1958, *Rao* 20177.

F. fulva Reinw. ex Bl.

A small tree with yellowish green fruits, fairly common. Margharita-Jairampur, Oct. 1959, *Rao* 19922.

F. hispida Linn. f.

A small tree with pinkish synconium, common. Margharita-Jairampur, Oct. 1959, *Rao* 19938 & 19947 ; Namsang-Soha, Oct. 1959, *Rao* 20331 ; Chenglang, 549 m, March 1958, *Murthy* 12905 ; Lailongsong, 510 m, June 1961, *Deb* 25777.

F. hirta Vahl

A shrub or a small tree with chocolate brown hypanthium ; common. Banfera, July 1961, *Deb* 26727 ; Khela, March 1958, *Murthy* 12955 ; Tipang, July 1961, *Deb* 25715 ; Namchick-Chenglang, Oct. 1959, *Rao* 20216.

F. longkdcensis Drake

Small tree ; fairly common. Deomali, June 1961, *Deb* 25897.

F. neriifolia J. E. Sm. var. **nemoralis** (Wall. ex Miq.) Corner

Large tree with paired synconium at axil; common. Chennhang, June 1961, *Deb* 26235 ; Langsong forest, June 1961, *Deb* 26146.

F. pomifera Wall. ex Miq.

Tree with tan coloured synconium ; common in places. Chennhang, June 1961, *Deb* 26180.

F. prostrata Wall. ex Miq.

Shrub about 6 m in height with brick red hypanthium, Nagnu-Niausa, Aug. 1958, *Panigrahi* 14878.

F. semicordata Buch.-Ham. ex J. E. Smith

F. cunea Buch.-Ham. ex Roxb.

Small tree, in fruit ; common. Lailongsong, 510 m, June 1961, *Deb* 25778 ; Laju, June 1961, *Deb* 25992.

F. subulata Bl.

Small tree ; common. Pungchow, July 1961, *Deb* 16592 ; Banfera, July 1961, *Deb* 26742.

URTICACEAE

Boehmeria assamica C. B. Clarke

Shrub ; fairly common. Chegum, July 1961, *Deb* 26490.

B. macrophylla D. Don

Tall shrub up to 7 m in height with pendulous inflorescence ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20005 & 20158 ; Tinchha, Aug. 1958, *Murthy* 12995.

B. malabarica Wedd.

Shrub about 10 m in height, with creamy flowers ; scarce. Pangsupass, Oct. 1959, *Rao* 20007.

B. platyphylla D. Don

Shrub ; flowers greenish brown or reddish ; common. Chennhang, June 1961, *Deb* 26177 ; Deomali, Oct. 1959, *Rao* 20318.

B. platyphylla D. Don var. **zeylanica** Wedd.

Shrub ; rare. Khonsa-Laju, June 1961, *Deb* 25976.

B. sidaefolia Wedd.

An undershrub with pale yellow flowers ; common. Jairampur, Oct. 1959, *Rao* 19994 ; Khonsa, June 1961, *Deb* 25994.

B. tirapensis Deb et Dutta

Shrub or small tree with monoecious flowers. Kothong, June 1961, *Deb* 26081. Described as a new species by the authors in *Bull. Bot. Surv. India* 90 (11) : 782, 1964.

Chamabainia cuspidata Wt.

A gregarious herb ; common along the Burma border. Noglo, June 1961, *Deb* 26334.

Debregeasia longifolia (Burm.) Wedd.

A tall spreading shrub ; fruits brick-red or orange-yellow in colour ; fairly common. Soha village, 1067 m, Oct. 1959, *Rao* 20354 ; Pangsupass, March 1958, *Murthy* 12996 ; Wakka, July 1961, *Deb* 26494.

Elatostema surculosum Wight

A lithophytic herb ; fairly common. Khonsa ; June 1961, *Deb* 25963 ; Wakka, July 1961, *Deb* 26438 ; Chennhang, June 1961, *Deb* 26214 & 26254 ; Chenglang, 510 m, June 1961, *Deb* 25812.

E. dissectum Wedd.

A succulent herb ; scarce. Chenglang, 510 m, June 1961, *Deb* 25820.

E. lineolatum Wight

A herb of moist places ; common. Jangkeng village, June 1961, *Deb* 25869.

E. platyphyllum Wedd.

A herb of moist places ; common. Jangkeng village, June 1961, *Deb* 25868.

E. sessile Forst.

Herb ; rare. Chennhang, June 1961, *Deb* 26227.

Gironniera lucida Kurz

Tree in fruit ; rare. Chenglang, 510 m, June 1961, *Deb* 25800.

Laportea crenulata Gaud.

Shrub, about 5-10 m in height ; flowers greenish ; scarce. Pangsupass, Oct. 1959, *Rao* 20008.

Pilea bracteosa Wedd.

An undershrub in flower ; common. Chennhang, June 1961, *Deb* 26265 ; Khonsa, June 1961, *Deb* 25951 & 25977 ; Wakka, July 1961, *Deb* 26429.

P. scripta (Harm.) Wedd.

An undershrub with white flowers ; common. Chennhang, June 1961, *Deb* 26211, Kothong, June 1961, *Deb* 26175.

P. smilacifolia Wedd.

A succulent herb with small creamy white flowers ; rare. Pangsupass, Oct. 1959, *Rao* 20017.

Pouzolzia bennettiana Wt.

A semi-prostrate herb with greenish white to creamy white flowers ; scarce. Khela, March 1958, *Murthy* 12983, Laju, Aug. 1958, *Panigrahi* 14728 ; Khonsa, Aug. 1958, *Panigrahi* 14512 ; Pangsupass, Oct. 1959, *Rao* 20072 ; Kothong, June 1961, *Deb* 26026 & 26076 ; Tipang, June 1961, *Deb* 25708.

P. hispida Bennet

A prostrate herb in flowers and fruits ; common. Khonsa, June 1961, *Deb* 25921.

P. viminea Wedd.

A shrub with small white flowers ; fairly common. Jairampur, Oct. 1959, *Rao* 19929 ; Bimalpur, Sept. 1958, *Panigrahi* 17007 ; Wakka, July

1961, *Deb* 26465 ; Khonsa, June 1961, *Deb* 25994 & 26006 ; Longseck hillock, 1500 m, June 1961, *Deb* 25741.

P. viminea Wedd. var. **fulgens** Wedd.

A shrub with minute flowers ; scarce. Kothong, June 1961, *Deb* 26022.

Procris wightiana Wall. ex Wedd.

An epiphytic herb with greenish white flowers ; rare. Wanu, Sept. 1958, *Panigrahi* 15053 ; Laju, June 1961, *Deb* 25958 ; Deomali, Oct. 1959, *Rao* 20322 ; Jadua, July 1961, *Deb* 26658.

Sarcochlamys pulcherrima Gaud.

A tall shrub. Pangsupass, March 1958, *Murthy* 12997 ; Jangkeng village, June 1961, *Deb* 25867.

Villebrunea integrifolia Gaud.

A tall shrub with pale creamy yellowish white flowers. Fruits juicy white with a blackish tip. Khela, March 1968, *Murthy* 12976.

FLACOURTIACEAE

Casearia kurzii C. B. Clarke

A big tree in flowers and fruits. This is one of the most dominant trees of Noglo forest. Noglo, June 1961, *Deb* 26307.

C. vareca Roxb.

Medium sized tree, in fruit ; common. Jairampur, Oct. 1959, *Rao* 19954 ; Lailongsong, 510 m, June 1961, *Deb* 25796 ; Noglo, June 1961, *Deb* 26307.

Gynocardia odorata R. Br.

Medium sized tree in flowers and fruits ; common in places. Locally used as fish poison ; Jadua, July 1961, *Deb* 26660 ; Wakka, July 1961, *Deb* 26532.

PROTEACEAE

Helicia robusta Wall.

Scandent shrub ; rare. Raho, July 1961, *Deb* 26386.

PITTOSPORACEAE

Pittosporum podocarpum Gagnep.

Small tree ; fruits with the smell of mango ; common in places. Chennhang, June 1961, *Deb* 26234.

CAPPARIDACEAE

Capparis multiflora Hook. f. & Thoms.

Large woody climber ; scarce. Changlang, June 1961, *Deb* 26150.

Stixis suaveolens (Roxb.) Baill.

Roydsia suaveolens Roxb.

Scandent shrub with white fruits ; fairly common. Namchik-Chenglang, Oct. 1959, *Rao* 20217 ; Banfera, July 1961, *Deb* 26702.

VIOLACEAE

Viola diffusa Ging.

Herb, in flowers and fruits ; scarce. Lunwa, July 1961, *Deb* 26637.

V. arenata Bl.

Herb in flowers and fruits. Wakka, July 1961, *Deb* 27402.

V. patrinii DC.

Herb in flowers and fruits. Chennhang, June 1961, *Deb* 26193 ; Wakka, July 1961, *Deb* 26403.

POLYGALACEAE

Polygala arillata Buch.-Ham. ex D. Don

Shrub with yellow flowers ; common. Wakka, July 1961, *Deb* 26487.

Salomonia cantoniensis Lour.

Herb, in moist places with white purple or pink flowers ; common. Lailongsong, 510 m, June 1961, *Deb* 25841.

PASSIFLORACEAE

Adenia cardiophylla (Mast.) Engl.

A tendril climber with yellow flowers ; scarce. Banfera, July 1961, *Deb* 26745, Khonsa, June 1961, *Deb* 25978.

A. trilobata (Roxb.) Engl.

A tendril climber with pale yellow or white flowers ; scarce. Jadua-Banfera, July 1961, *Deb* 26684 ; Deomali, June 1961, *Deb* 25901 ; Lunwa, July 1961, *Deb* 26642.

Passiflora assamica Chakravarty

A tendril climber with globose berry ; fairly common. Kothong, June 1961, *Deb* 26038.

CUCURBITACEAE

Benincasa hispida (Thunb.) Cogn.

A tendril climber with yellow flower and edible fruits ; cultivated. Jairampur, Oct. 1959, *Rao* 19957.

Gomphogyne macrocarpa Cogn. emend Deb et Dutta in *Bull. Bot. Soc. Beng.* **19** (1) : 37, 1965.

A tendril climber ; rare. Langsang forest (Kothong), June 1961, *Deb* 26151. The description of the species has been amended in the reference cited above and it has been recorded therein for the first time outside the type locality.

Gymnostemma pentaphylla (Thunb.) Molina

A tendril climber with unisexual yellow flowers ; rare. Sept. 1958, *Panigrahi* 16982 ; Jangkeng village, June 1961, *Deb* 25856 ; Khonsa-Laju, June 1961, *Deb* 25947.

Lagenaria siceraria (Molina) Stanley

A tendril climber, monoecious, cultivated, scarce. Jairampur, Oct. 1959, *Rao* 19968.

Luffa cylindrica (Linn.) Roem.

A tendril climber with yellow flowers ; scarce. Chennhang, June 1961, *Deb* 26220.

Melothria heterophylla (Lour.) Cogn.

Solena heterophylla Lour.

A tendril climber with heterophyllous leaves ; flowers white ; fairly common. Chennhang, June 1961, *Deb* 26215 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20016 & 20047 ; Khonsa-Laju, June 1961, *Deb* 25987 ; Kothong, June 1961, *Deb* 26052.

M. perpusilla (Bl.) Cogn.

Zehneria maysorensis (Wt. & Arn.) Arn.

A tendril climber with yellow flowers ; scarce. Wakka, July 1961, *Deb* 26418.

M. leucocarpa (Bl.) Cogn.

A tendril climber with small creamy white flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20013.

Thladiantha calcarata (Wall.) C. B. Clarke

A tendril climber with yellow flowers ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20278 ; Chennhang, June 1961, *Deb* 25857 & 26221 ;

Kothang, June 1961, *Deb* 26064 & 26075 ; Longseck hillock, June 1961, *Deb* 25745.

T. hookeri C. B. Clarke ex Chakravarty var. **palmatifolia** Chakravarty, forma—**trifoliata** (Cogn.) Chakravarty

A tendril climber with yellow flowers ; common. Deomali, June 1961, *Deb* 25884 ; Lailongsong, 510 m, June 1961, *Deb* 25795 ; Chennhang, June 1961, *Deb* 2626 ; Raho-Wakka, July 1961, *Deb* 26401 & 26410.

Trichosanthes bracteata (Lamk.) Voigt

A tendril climber with white flowers ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20045 ; Lailongsong, 510 m, June 1961, *Deb* 25821 ; Kothong, June 1961, *Deb* 26051 ; Jangkeng Village, June 1961, *Deb* 25855 ; Langsang forest, June 1961, *Deb* 26153.

T. cucumerina Linn.

A tendril climber. Female flowers white. Berry brick red; rare. Margharita-Jairampur, Oct. 1959, *Rao* 19911 ; Kothong, June 1961, *Deb* 26069.

T. wallichiana (Seringe) Wight

A tendril climber. Female flowers white ; scarce. Langsang forest, June 1961, *Deb* 26152 ; Raho, July 1961, *Deb* 26387 ; Pungchow, July 1961, *Deb* 26578.

BEGONIACEAE

Begonia palmata D. Don

A succulent herb with creamy-white flowers ; common. Grows gregariously in shaded regions of the forest. Chenglang-Khela, Oct. 1959, *Rao* 20259 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20019 & 20034 ; Raho-Wakka, July 1961, *Deb* 26425 ; Chegum-Wakka, July, 1961, *Deb* 26474 ; Chennhang, June 1961, *Deb* 26253 ; Noglo, June 1961, *Deb* 26310 & 26311 ; Pungchow, July 1961, *Deb* 26566.

B. cathcartii Hook. f. & Th.

A small succulent herb with one-winged fruits ; common in shaded places. Nampong-Pangsupass, Oct. 1959, *Rao* 20063 ; Deomali, June 1961, *Deb* 25900.

B. roxburghii A. DC.

A succulent herb with white flowers ; common. This species is used as a vegetable by the local people. Chenglang-Khela, Oct. 1959, *Rao* 20065 ; Wakka, July 1961, *Deb* 26539 ; Khonsa-Laju, June 1961, *Deb*

25999 ; Chennhang, June 1961, *Deb* 26225 ; Khela-Chenglang, March 1958, *Murthy* 12984 ; Banfera-Kanubari, July 1961, *Deb* 26747 ; Noglo, June 1961, *Deb* 26325.

B. silhetensis C. B. Clarke

A herb of moist places ; scarce. Nampong-Pangsupass, 75 m, March 1958, *Murthy* 13002.

ELAEOCARPACEAE

Elaeocarpus braceanus Watt ex C. B. Clarke

A medium-sized tree with white flowers and fruits. One of the dominant trees of this locality. Pungchow, July 1961, *Deb* 26616.

E. lanceaefolius Roxb.

A medium-sized tree with white flowers and fruits. One of the dominant trees in the locality ; common. Chennhang, June 1961, *Deb* 26232.

E. tectorius (Lour.) Poir.

A large tree with white flowers ; rare. Jadua-Banfera, July 1961, *Deb* 26665.

TILIACEAE

Grewia denticulata Wall. ex Voigt

A scandent shrub or a small tree with brown flowers and fruits ; scarce. Namchik, 152 m, Oct. 1959, *Rao* 20191 ; Deomali, June 1961, *Deb* 25898.

Triumfetta tomentosa Noronha

An undershrub in yellow flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20027 ; Chenglang-Khela, 450 m, Oct. 1959, *Rao* 20266 ; Noglo-Laju, June 1961, *Deb* 26374.

STERCULIACEAE

Abroma augusta (Linn. f.)

A shrub with dark brown flowers and fruits ; common. Jairampur, Oct. 1959, *Rao* 19967 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20037 ; Lailongsong, 510 m, June 1961, *Deb* 25792.

Byttneria aspera Colebrooke

A diffused climber ; scarce. Deomali, June 1961, *Deb* 25880.

Pterospermum acerifolium Willd.

A big tree about 20-30 m. in height; common. Namchik, 152 m, Oct. 1959, *Rao* 20196.

Sterculia indica Merr.

A small or a big tree with creamy yellow or red fruits; fairly common. Langsang Forest, June 1961, *Deb* 26143; Jangkeng Village, June 1961, *Deb* 25861; Lailongsong (Chenglang), 510 m, June 1961, *Deb* 25803; Wakka, July 1961, *Deb* 26512 & 26515.

MALVACEAE

Gossypium herbaceum Linn.

A shrub. An escape from cultivation, rare. Niausa, July 1961, *Deb* 26554.

Hibiscus pungens Roxb.

A tall herb with conspicuous yellow flowers; common. Namsang-Soha, Oct. 1959, *Rao* 20333; Namchik-Chenglang, Oct. 1959, *Rao* 20210; Margharita-Jairampur, Oct. 1959, *Rao* 19940.

Kydia calycina Roxb.

A small tree; fairly common. Chenglang-Khela, Oct. 1959, *Rao* 20264.

Urena lobata Linn.

A herb in pinkish flowers; common. Margharita-Jairampur, Oct. 1959, *Rao* 19945; Niausa, July 1961, *Deb* 26555.

MALPIGHIACEAE

Aspidopterys glabriuscula (Wall.) A. Juss.

A shrub with small white flowers; scarce. Wakka, July 1961, *Deb* 26511.

EUPHORBIACEAE

Actephila excelsa Muell.-Arg.

Shrub or small tree; rare. Chenglang, 570 m, Oct. 1959, *Rao* 20230; Longseck Hillock, 1500 m, June 1961, *Deb* 25742.

Alcornea tiliaefolia Muell.-Arg.

Shrub with unisexual flowers; common. Grows gregariously in secondary succession. Deomali, June 1961, *Deb* 25893; Jadua-Banfera, July 1961, *Deb* 26671.

Andrachne cordifolia (Decne) Muell.-Arg.

A shrub about 1 m in height. Fruits globose ; scarce. Deomali, Oct. 1959, *Rao* 30309.

Antidesma diandrum (Roxb.) Roth

Shrub. Fruits reddish, one seed matures, the other is abortive ; scarce. Longseck Hillock (Chenglang), 1500 m, June 1961, *Deb* 25729.

A. bunius (Linn.) Spreng.

A shrub of about 2-3 m. height with orange-red flowers ; scarce. Pungchow, July 1961, *Deb* 26615.

A. roxburghii Wall.

Tree ; rare. Banfera-Longhoi, Sept. 1958, *Panigrahi* 16722 & 16734.

Aporosa roxburghii Baill.

Small tree in fruit ; scarce. Banfera-Kanubari, July 1961, *Deb* 26741 ; Banfera, July 1961, *Deb* 26706.

Baccaurea sapida (Roxb.) Muell.-Arg.

Small tree. Longseck Hillock, June 1961, *Deb* s.n. ; Khela, June 1961, *Deb* 25937.

Baliospermum corymbiferum Hook. f.

Shrub or small tree with small white flowers ; common ; Wakka, July 1961, *Deb* 26513 ; Pungchow, July 1961, *Deb* 26614 & 26621.

B. calycinum Muell.-Arg.

Shrub or small tree with very small white flowers ; common. Mainly in sheltered and shady places. Wakka, July 1961, *Deb* 26516 ; Khonsa-Laju, July 1961, *Deb* 25955.

B. montanum (Willd.) Muell.-Arg.

Small tree with white flowers ; fairly common. Noglo, June 1961, *Deb* 26327.

Bischofia javanica Bl.

A big tree, in fruit ; scarce. Lailongsong, 510 m, June 1961, *Deb* 25807 ; Khela, June 1961, *Deb* 25934.

Breynia patens Rolfe

A shrub in small, monoecious flowers ; fairly common. Wakka, July 1961, *Deb* 26417 ; Lailongsong (Chenglang), 510 m, June 1961, *Deb* 25810.

Bridelia pubescens Kurz

A small tree in flower ; common. Kothong, June 1961, *Deb* 26027 ; Pungchow, July 1961, *Deb* 26598.

B. cuneata Gehrm.

Shrub with small yellow flowers ; fairly common. Wakka-Nagminu, July 1961, *Deb* 26533.

Croton caudatus Geisel.

Scandent shrub ; common. Deomali, June 1961, *Deb* 25890.

C. chlorocalyx Wall. ex Muell.-Arg.

Monoecious shrub ; common. Pungchow, July 1961, *Deb* 26605.

Drypetes elata (Bedd.) Pax. & Hoffm.

Big tree. One of the dominant trees of this forest ; common. Noglo, June 1961, *Deb* 26308 ; Chennhang, June 1961, *Deb* 26241.

Euphorbia microphylla Heyne

Small prostrate herb ; not rare. Jairampur, Oct. 1959, *Rao* 19971.

Glochidion acuminatum Muell.-Arg.

Shrub, in flower ; scarce. Wakka-Nagminu, June 1961, *Deb* 26541.

Kirganelia reticulata (Poir.) Baill.

Shrub with unisexual, orange yellow flowers and orange-red fruits ; common. Noglo-Laju, June 1961, *Deb* 26373.

Macaranga denticulata (Bl.) Muell.-Arg.

Shrub or small tree with dirty brown flower buds ; common. Chenglang, 549 m, March 1948, Murthy 12910 ; Kothong, June 1961, *Deb* 26032 ; Lailongsong (Chenglang), 510 m, June 1961, *Deb* 25809.

M. nepalensis Muell.-Arg.

Small tree, rare. Chennhang, June 1961, *Deb* 26247.

M. roxburghianus Muell.-Arg.

Small tree. Common. Deomali, June 1961, *Deb* 25878.

Manihot esculenta Crantz.

The Tapioca shrub, cultivated extensively for its edible roots. Oct. 1959, *Rao* s.n.

Ostodes paniculata Bl.

Small tree ; scarce. Pungchow, July 1961, *Deb* 26626.

Phyllanthus urinaria Linn.

A herb in flower, mostly in marshy places ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20082 ; Lailongsong, 510 m, June 1961, *Deb* 25831 ; Wakka-Nagminu, July 1961, *Deb* 26544.

Sauropus stipitatus Hook. f.

Shrub with monoecious, yellow flowers ; rare. Wakka, July 1961, *Deb* 26520.

S. trinervius Muell.-Arg.

Shrub with monoecious, white flowers, rare. Pungchow, July 1961, *Deb* 26623 ; Banfera-Kanubari, July 1961, *Deb* 26733.

THEACEAE

Eurya acuminata DC.

Shrub, in fruit ; common. Konsa-Kheti, Aug. 1958, *Panigrahi* 14571.

Schima wallichii Choisy

Medium-sized tree with white flowers ; common. Namsang-Soha, Oct. 1959, *Rao* 20332, Wakka, July 1961, *Deb* 26502, Khonsa-Laju, June 1961, *Deb* 25989 ; Khonsa, June 1961, *Deb* 25911.

SAURAUIACEAE

Saurauja fasciculata Wall.

A shrub about 5 m in height, fruits red brown when ripe ; rare. Wakka, Aug. 1958, *Panigrahi* 14916.

S. napaulensis DC.

Shrub or small tree with pinkish-white flowers and red fruits ; common. Tipang, June 1961, *Deb* 25717 ; Khonsa-Laju, June 1961, *Deb* 25949.

S. macrotricha Kurz

Shrub with pink flowers ; common. Noglo (Burma border), June 1961, *Deb* 26338 ; Khonsa-Laju, June 1961, *Deb* 26991 ; Wakka-Nagminu, July 1961, *Deb* 26528.

S. panduana Wall.

Tree with rose-coloured flowers ; common. Kothong, June 1961, *Deb* 26079.

S. roxburghii Wall.

Shrub or small tree with pinkish-white flowers and pinkish fruits ; common. Margharita to Jairampur, Oct. 1959, *Rao* 19961 ; Deomali, June 1961, *Deb* 25905 ; Banfera, July 1961, *Deb* 26730.

ACTINIDIACEAE

Actinidia callosa Lindl.

Climbing shrub with white flowers ; rare. Khonsa-Laju, June 1961, *Deb* 25953 ; Chennhang, June 1961, *Deb* 26275 ; Chegum-Wakka, July 1961, *Deb* 26461.

DIPTEROCARPACEAE

Dipterocarpus macrocarpus Vesque

A large tree about 40-70 m in height, most dominant in the locality, in fruits ; common. Deomali, Oct. 1959, *Rao* 20324.

ERICACEAE

Rhododendron arboreum Smith

Shrub or small tree, sometimes epiphytic ; scarce. Wakka, 2100 m, July 1961, *Deb* 26485.

R. vaccinioides Hook. f.

An epiphytic, pendent shrub, with red flowers ; common. Wakka, July 1961, *Deb* 26441.

VACCINIACEAE

Agapetes obovata Hook. f.

A small creeping herb ; common. Pangsupass, March 1958, *Murthy* 13014.

Corallobotrys acuminata Hook. f.

An epiphytic shrub with red flowers ; common. Raho-Wakka, July 1961, *Deb* 26423.

Vaccinium manipurensis (Wall. ex Brandis) Sleumer

An epiphyte ; flowers in terminal raceme ; common. Chennhang, June 1961, *Deb* 26271.

V. retusum Hook. f.

An epiphyte ; common. Chennhang, June 1961, *Deb* 26256.

V. vacciniaceum (Roxb.) Sleumer

An epiphyte with white flowers and globose fruits ; scarce. Chennhang, June 1961, *Deb* 26269 & 26270 ; Noglo (Burma Border), June 1961, *Deb* 26351.

HYPERICACEAE

Hypericum elodeoides Choisy.

A diffused herb with yellow flowers, scarce. Noglo-Laju, June 1961, *Deb* 26370 ; Langsang forest, June 1961, *Deb* 26129.

H. hookerianum Wt. & Arn.

An undershrub with yellow flowers ; scarce. Wakka, July 1961, *Deb* 26509.

H. japonicum Thunb.

A herb with yellow flowers ; common. Noglo-Laju, June 1961, *Deb* 26372.

H. monanthemum Hook. f. & Th.

A herb with yellow flowers ; scarce. Langsang forest, June 1961, *Deb* 26130.

H. patulum Thunb.

An undershrub with solitary red flowers ; scarce. Noglo, June 1961, *Deb* 26316.

GUTTIFERAE

Garcinia pedunculata Roxb.

A climber with creamy-yellow flowers ; rare. Banfera-Kanubari, July 1961, *Deb* 26735.

MYRTACEAE

Syzygium fruticosum (Roxb.) DC.

Small tree ; scarce. Wakka, July 1961, *Deb* 26538.

S. cumini (Linn.) Skeels.

Medium-sized tree with black fruits ; scarce. Jadua-Banfera, July 1961, *Deb* 26672 ; Lailongsong, June 1961, *Deb* 25775.

RHIZOPHORACEAE

Carallia lucida Roxb.

A small tree with yellowish-white flowers. One of the dominant trees of this forest ; common. Pungchow, July 1961, *Deb* 26604 ; Chegum, July 1961, *Deb* 26467 ; Khela, June 1961, *Deb* 25936.

SONNERATIACEAE

Duabanga grandiflora (Roxb. ex DC.) Walp.

A large tree with spreading branches, in fruit ; very common. Lailongsong, June 1961, *Deb* 25772.

COMBRETACEAE

Combretum flagrocarpum C. B. Clarke

A scandent shrub with winged fruits ; scarce. Chenglang, Oct. 1959, *Rao* 20226 ; Khonsa-Laju, June 1961, *Deb* 25967.

Terminalia myriocarpa Heurck. & Muell.-Arg.

A big tree with creamy white flowers ; common. Namchick, Oct. 1959, *Rao* 20209 ; Deomali, Oct. 1959, *Rao* 20310.

MELASTOMATACEAE

Backeria assamica (Cl.) Raizada in Ind. For. **94** (6) : 435, 1968.

Anplectrum assamicum C. B. Clarke

Shrub with red or pink flowers ; common. Tipang, June 1961, *Deb* 25701.

Blastus cochinchinensis Lour.

An undershrub with pinkish-white flowers and minute, brown fruits; common. Namsang-Soha, Oct. 1959, *Rao* 20338, Deomali, June 1961, *Deb* 25887 ; Jadua-Banfera, July 1961, *Deb* 25880.

Medinilla himalayana Hook. f.

An epiphyte with purple flowers ; fairly common. Raho-Wakka, July 1961, *Deb* 26414.

Melastoma normale D. Don

Shrub with mauve-coloured or pinkish-violet flowers, scarce. Kothong, June 1961, *Deb* 26105 ; Chenglang-Khela, March 1958, *Murthy* 12937.

Osbeckia crinita Benth.

Shrub with small, purple or rosy-red flower. Margharita-Jairampur, Oct. 1959, *Rao* 19926 ; Deomali, June 1961, *Deb* 25886.

O. rostrata D. Don

Shrub ; common. Jadua-Banfera, July 1961, *Deb* 26682.

Oxyspora paniculata (D. Don) DC.

Shrub up to 3 m in height with deep red flowers ; scarce. Khonsa-Laju, June 1961, *Deb* 25969.

Sarcopyramis nepalensis Wall.

A small herb of moist situation, with reddish-brown flowers. Scarce. Nampong-Pangsupass, March 1958, *Murthy* 13000 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20148 & s.n. ; Raho-Wakka, July 1961, *Deb* 26404 ; Banfera-Kanubari, July 1961, *Deb* 26739.

Sonerila khasiana C. B. Clarke

Small herb with pinkish flower ; common in shade. Nampong-Pangsupass, Oct. 1959, *Rao* 20035.

ICACINACEAE

Gomphandra axillaris Wall. ex Bedd.

Shrub or small tree with small white flowers ; common. Lunwa, July 1961, *Deb* 26639 ; Longseck Hillock, 1500 m, June 1961, *Deb* 25739.

CELASTRACEAE

Celastrus championii Benth.

Shrub ; in fruit ; fairly common. Chegum-Wakka, July 1961, *Deb* 26473 ; Pungchow, July 1961, *Deb* 26574.

C. monospermus Roxb.

Small tree ; in fruit, seeds red. Chennhang, June 1961, *Deb* 26242.

ERYTHROPALACEAE

Erythropalum vagum Mast.

Shrub with pinkish fruits ; scarce. Namsang-Soha, Oct. 1959, *Rao* 20336.

LORANTHACEAE

Helixanthera ligustrina (Wall.) Danser

A bushy parasitic shrub with small red flowers ; scarce. Chenglang, March 1958, *Murthy* 12908 ; Khela, June 1961, *Deb* 25929, 25931, & 25932 ; Langsang forest, June 1961, *Deb* 26125.

Helixanthera parasitica Lour.

Loranthus pentapetalus Roxb.

A parasitic shrub with bright red flowers ; rare. July 1961, *Deb* 26381.

H. terrestris (Hook. f.) Danser

A parasite on *Saurauja* sp., with pink flowers ; scarce. Lailongsong ; June 1961, *Deb* 25802.

Macrosolen cochin-chinensis (Lour). V. Tiegh.

Parasite on *Mallotus* and other trees ; common. Margharita, Oct. 1959, *Rao* 19942.

Scurrula parasitica Linn.

Parasite on *Saurauja* sp. with reddish flowers ; common. Chegum, July 1961, *Deb* 26460, Soha, Oct. 1959, *Rao* 20360 ; Pungchow, July 1961, *Deb* 26584.

Viscum articulatum Burm. f.

A parasite on *Acer* sp. with flattened internodes ; scarce. Noglo, June 1961, *Deb* 26325 ; Chennhang, June 1961, *Deb* 26278.

V. monoicum Roxb. ex DC.

Parasitic or semiparasitic on *Alnus* sp. ; scarce. Pungchow, July 1961, Deb 26569 ; Banfera-Kanubari, July 1961, *Deb* 26748.

BALANOPHORACEAE

Balanophora dioica R. Br. ex Royle

A dark red root parasite on humus soil with dark brown flowers ; common. Chenglang, Oct. 1959, *Rao* 20224.

RHAMNACEAE

Gouania leptostachya DC.

A woody climber about 5 m in height with pale greenish violet flowers ; fairly common. Jairampur, Oct. 1959, *Rao* 19982 ; Khonsa-Laju, June 1961, *Deb* 25948, Langsang forest, June 1961, *Deb* 26132.

Hovenia dulcis Thunb.

A small tree with white flowers; fairly common. Sometimes cultivated. Pungchow, July 1961, *Deb* 26594.

Rhamnus nepalensis Wall.

A scandent shrub in bud ; scarce. Namchik, Oct. 1959, *Rao* 20173,

Zizyphus funiculosa Buch.-Ham.

A scandent shrub with orange-coloured fruits ; scarce. Lailongsong, 510 m, June 1961, *Deb* 25779.

VITACEAE

Ampelocissus barbata (Wall.) Planch.

A gigantic climber, in fruit. Banfera-Longhoi, Sept. 1958, *Panigrahi* 16724 ; Jadua-Banfera, July 1961, *Deb* 26668.

Cayratea japonica Gagnep.

A tendril climber, in young fruit ; scarce. Longseck hillock, 1500 m, June 1961, *Deb* 25747 ; Wakka, July 1961, *Deb* 26506 ; Kothong, June 1961, *Deb* 26054.

C. pedata A. Juss.

A climber in fruit ; common. Lailongsong, 510 m, June 1961, *Deb* 25806.

Cissus assamica (Laws.) Graib.

A tendril climber with yellow flowers ; fairly common. Deomali, Oct. 1959, *Rao* 20308 ; Deomali (West of Khonsa), June 1961, *Deb* 25891.

C. repanda (Wt. & Arn.) Vahl

A rare climber. Banfera-Kanubari, July 1961, *Deb* 26732.

Tetrastigma bracteolatum (Wall.) Planch.

A climber with deep blue fruits ; common. Wakka, March 1958, *Murthy* 13004.

T. serrulatum (Roxb.) Planch.

A tendril climber in fruit ; scarce. Kothong, June 1961, *Deb* 26055.

T. rumicisperma (Laws.)

A tendril climber with small flowers and dull pinkish fruits ; scarce. Namchang-Soha, Oct. 1959, *Rao* 20337 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20028 ; March, 1958, *Murthy* 13006.

LEEACEAE

Leea acuminata Wall.

Shrub. Flowers pentamerous, petals yellowish ; scarce. Lailongsong, 510 m, June 1961, *Deb* 25781.

L. bracteata Clarke

Shrub ; scarce. Lailongsong, 510 m, June 1961, *Deb* 25783.

L. indica (Burm. f.) Merrill

A climbing shrub ; fairly common. Chennhang, June 1961, *Deb* 26281 ; Lailongsong, 510 m, June 1961, *Deb* 25785.

L. robusta Roxb.

Shrub about 3 m. in height with brown to bluish-ripe fruits ; common. Raho, July 1961, *Deb* 26380.

L. umbraculifera Clarke

A tall shrub in fruit ; common. Namchik, Oct. 1959, *Rao* 20184 ; Deomali, Oct. 1959, *Rao* 20313 ; Banfera-Kanubari, July 1961, *Deb* 26736.

MYRSINACEAE

Ardisia griffithii C. B. Clarke

A small tree with small flowers ; scarce. Longseck hillock, 1500 m, June 1961, *Deb* 25740 ; Pungchow, July 1961, *Deb* 26610.

A. membranacea Wall. ex A. DC.

A shrub with white flowers ; scarce. Wakka, July 1961, *Deb* 26519.

A. undulata C. B. Clarke

A shrub with rose-coloured small flowers ; rare. Chennhang, June 1961, *Deb* 26280.

A. virens Kurz

A shrub with pinkish flowers and brown fruits ; scarce. Langsang forest, June 1961, *Deb* 26149 ; Longseck hillock, 1500 m, June 1961, *Deb* 25734.

Embelia parviflora Wall. ex A. DC.

A shrub with deep violet flowers and pendent branches ; common. Raho-Wakka, July 1961, *Deb* 26431.

E. ribes Burm. f.

A shrub with very small flowers, scarce. Chenglang, March 1958, *Murthy* 12932.

E. vestita Roxb.

Shrub. This occurs as an undergrowth in the forest; scarce. Kothong, June 1961, *Deb* 26062.

Maesa chisia Buch.-Ham. ex D. Don

A shrub with white flowers. Occurs as an undergrowth in the open forest; scarce. Nampong-Pangsupass, March 1958, *Murthy* 12993; Langsang forest, June 1961, *Deb* 26134, Tipang, June 1961, *Deb* 25718.

M. indica Wall.

A shrub with creamy-white flowers; common Chenglang, March 1958, *Murthy* 12903; Khonsa-Laju, June 1961, *Deb* 25945.

M. indica Wall. var. **angustifolia** Hook. f. & Thoms.

A shrub with small, creamy-white flowers; scarce. Mostly in moist soil. Lailongsong, June 1961, *Deb* 25784; Khela, March 1958, *Murthy* 12964.

Myrsine semiserrata Wall.

A small tree in fruits; common. Chenglang, June 1961, *Deb* 26251; Noglo, June 1961, *Deb* 26326.

EBENACEAE

Diospyros amoena Wall. ex A. DC.

A small tree with greenish-white flowers. Fruit is used as fish poison; scarce. Jadua, July 1961, *Deb* 26661.

RUTACEAE

Citrus medica Linn. var. **acida** Hook. f.

A common shrub. Cultivated. Soha village, Oct. 1959, *Rao* 20384.

C. demoruhocarpa Lush.

A cultivated form. Soha village, Oct. 1959, *Rao* 20385.

Evodia meliaefolia Benth.

A tall shrub, in fruit. Khonsa, June 1961, *Deb* 25944.

Micromelum integerrimum (Roxb.) Wt. & Arn. ex M. Roem.

Shrub with dull green flowers; scarce. Jairampur, Oct. 1959, *Rao* 19990.

Zanthoxylum acanthopodium DC.

Tall shrub with globose, red fruits ; common. Raho to Wakka, July 1961, *Deb* 26398 ; Khonsa-Laju, June 1961, *Deb* 25959 ; Pungchow, July 1961, *Deb* 26600.

Z. armatum DC.

Z. alatum Roxb.

Shrub with greenish-brown fruits, strongly aromatic ; cultivated for leaves and fruits used in curries ; commonly cultivated in homestead compounds. Soha village, Oct. 1959, *Rao* 20383.

Z. ovalifolium Wight

Shrub about 5 m in height with deep red fruits ; scarce. Wakka, Aug. 1958, *Panigrahi* 14919.

SIMAROUBACEAE

Picrasma javanica Bl.

A tall shrub in fruit ; scattered. Lailongsong, 510 m., June 1961, *Deb* 25798.

MELIACEAE

Aglaia chittagonga (Hiern) Miq.

A small tree in flower ; flower fragrance similar to that of *Artocarpus heterophyllus* Lamk. ; scarce. Langsang forest, June 1961, *Deb* 26126 ; Raho-Wakka, July 1961, *Deb* 26413.

Dysoxylum binectariferum Hook. f.

A small tree in flower ; rare. Pungchow, July 1961, *Deb* 26611.

SAPINDACEAE

Allophylus zeylanicus Linn.

A tall shrub with small white flowers ; scarce. Pungchow, July 1961, *Deb* 26575, Deomali, June 1961, *Deb* 25894.

A. zeylanicus Linn. var. **grandifolia** Hiern.

Shrub with small white flower ; rare. Kanubari, July 1961, *Deb* 26759.

Alphania rubra (Roxb.) Radlk.

Tall shrub. Khela, March 1958, *Murthy* 12963.

Lepisanthes burmanica Kurz

A small tree with orange-yellow flowers ; scarce. Deomali, June 1961, *Deb* 25895 ; Jadua, July 1961, *Deb* 26656.

PODOACEAE

Dobinea vulgaris Buch.-Ham.

Shrub, in fruit. Fruits winged, one-seeded ; rare. Langsang forest, June 1961, *Deb* 26158.

SABIACEAE

Meliosma pinnata Roxb.

A small bushy tree with small, pale purple-white flowers ; common. Tipang, June 1961, *Deb* 25710 ; Lailongsong (Chenglang), June 1961, *Deb* 25782.

M. simplicifolia (Roxb.) Walpers

Tree ; scarce. Wakka-Nginu, July 1961, *Deb* 26543.

(*to be continued*)

Observations on the Wildlife Sanctuaries of India[1]

BY

R. H. WALLER

INTRODUCTION

The report attempts to combine personal observations with certain scientific facts about ecological conditions and animal populations. For this purpose I covered India from Kerala to Kashmir and from Assam to Rajasthan between March and August 1970, most of which was spent in the jungle—mainly in the sanctuaries and parks—with two weeks at the end of intensive talks in Delhi with all those concerned with Wildlife Conservation.

Fifteen sanctuaries were covered. In all of these the excellent co-operation and help from the staff of the Forest Service, from Chief Conservator to Forest Guards, is gratefully acknowledged.

The original report was about 40,000 words so this account can only include parts which are thought to be of particular interest with a brief summary of others.

The description of habitat, area and position will be omitted from every sanctuary or reserved forest area described since it is assumed that Indian members know these details or can readily look them up.

PART 1

OBSERVATIONS ON SOME INDIAN WILDLIFE SANCTUARIES AND RESERVED FOREST AREAS

Nilgiri Plateau

The main purpose of my camp at Bangi Tappal was to view and photograph the Nilgiri Tahr. In four days I and my two shikaris criss-crossed the area west of Bangi Tappal, walking ten to fifteen miles a day. This area is totally uninhabited.

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[1] Excerpts from a report submitted to I.U.C.N. and W.W.F. in November, 1970

In the four days we saw 195 separate individuals, and in one single day 115 in herds of 44-41-30. All were seen on the highest, usually rocky, slopes of the open grassland at about 2250 m (7500 ft) grazing and resting in the sun or the shade of the rocks ; two herds were watched going warily down to water, always where the stream was clear of forest. Tahr are seen in the open at all hours of the day.

The approximate composition of the herds seen and the situation was :—

(1) 45 head ; of which 16 were kids and 4 or 5 young bucks, the remainder does. It is difficult to distinguish young bucks from does as both are grey, whereas older bucks are brownish black. This herd got our wind when it changed, and was off across the valley at great speed.

(2) 35 head ; of which 12 were kids and 2 young bucks ; the remainder were does. They passed us, when hidden behind rocks, going down to water.

(3) 30 head ; of which 8 were kids and the rest does. There may have been some young bucks, but this herd was seen approaching water from some way off.

(4) 44 head ; of which 14 were kids, 4 or 5 young bucks and one old buck or ' saddle-back ' (so called from the light patch on the dark back acquired with age). The ' saddle-back ' was lying apart from the rest of the herd, with his own sentinel doe guarding him. After a long and painful stalk, it was she who saw me, not the sentinel of the main herd, and thwarted my photo. Their sight is excellent and in marked contrast to that of the sambar, which can be stalked quite easily in similar open country, provided one is approaching ' up wind ' and movements are slow.

During the season of hot weather the ' saddle-backs ' are mostly separate from the herds. We searched for them to the south-western edge of the hills but were unlucky.

(5) 41 head ; of which 10 were kids and 3 or 4 young bucks. It was with this herd that I had the fascinating experience of them all moving towards me from some danger below. I had approached from above, between rocks, and was precariously hanging on a small cliff when, to my annoyance, I heard their alarm call—a curious snorting whistle—and knew the wind must have changed. But, as the position of the alarm signal remained static, I edged along the cliff to see the herd moving towards me over a grassy slope, while the sentinels continued to call, looking downhill. Following their line of sight I saw a light-coloured movement on the edge of the shola about 100 metres below which was almost certainly a panther abandoning his stalk. There are no people in this area and my two shikaris had remained where I left them, on the far side of the hill.

Panther are the main enemy of the tahr. Tigers, even when more abundant here, were not a great danger to them, being too heavy to move swiftly in steep places as the panther can.

The panther is certainly not common in this area, but is not as rare as the tiger. In the four days, we saw only two separate sets of tiger pug marks made, according to my shikaris, within the previous three days.

Three weeks before my visit, one of the shikaris had seen a tiger walking up a valley about three kilometres from our camp. But, he added, this was now a rare occurrence and we would count ourselves very lucky if we saw one ; whereas only five years ago he reckoned a visitor would be unlucky *not* to see a tiger within four energetic days in this area. I found a similar rapid decline in tiger numbers over the last five years in other parts of India.

Only 14 Sambar were seen : 2 were solitary stags, still in hard horn at the end of March, 2 were fawns and 10 hinds. The increase of sambar is essential if tiger is to make a come-back in this very promising, untouched and uninhabited area. The sambar is, at this height, almost his only prey. Wild Boar tend to remain at lower levels near cultivation and I saw no evidence of gaur.

This area is, to my knowledge, almost unique in India in having great wildlife potentialities and at the same time being completely free from habitation, cultivation, grazing by domestic stock and forestry operations. The meagre top soil on the lateritic rock makes it unsuitable for cultivation ; and the Forestry Dept. already have over 1000 sq km for their eucalyptus and wattle plantations in a wide circle round Ootacamund. Shooting and fishing are at the moment allowed but all licences are strictly controlled by the excellent Nilgiri Wildlife Association. There are threats of more reservoirs, H.E. projects and plantations, so the sooner a sanctuary for the tahr is declared the better. Controlled shooting of ‘ saddle-backs ’ by licence-holders could still continue, acting as a form of cropping.

Sigur Reserved Forest

The Elephant (*Elephas maximus*) is not only common in this area, it is a menace which needs attention. There are too many and they are bad tempered and dangerous. A German photographer was killed here two years ago, and two or three Indian peasants are victims each year. There seems no system of control until an elephant has killed at least one man and is prescribed as a ‘ rogue ’. Only then can it be shot.

Their bad tempers are a direct result of their uncontrolled numbers. They raid the neighbouring crops, having destroyed much of their own habitat, and then get peppered with shot from ancient guns or have burning flares thrown at them. One I saw was pock-marked with little bumps where the shots had lodged and festered. It is most unpleasant operating in jungles infested with such elephants and even my well-experienced shikari was nervous when walking. At intervals along some of the rivers, where the elephants come to drink and to eat the bamboos, the villagers have put notched poles or primitive ladders against the bigger trees for quick retreat to safety !

The Wildlife Officer for Mysore is well aware of this state of affairs, but rightly asks for help with an elephant census before starting any culling. There is an urgent need for an elephant census in Bandipur and Mudumalai sanctuaries and the reserved forest bordering them.

The Wild Dog or Dhole (*Cuon alpinus*) are numerous, and are partly responsible for the decline in numbers of the Sambar. Early one morning from the top of a hill we watched a tragedy unfold, from the first encircling by wild dog of three sambar hinds to the final destruction of one of them beside the river. We were too far off to effect any rescue. The tragedy was not the killing but the method and the apparent resignation of the sambar to its fate ; and the consequent feeling that with large numbers of wild dog in the area the rather stupid sambar, in contrast to the alert chital, is doomed here to a fast decline in numbers.

We first spotted the three sambar hinds about 500 metres down the steep grassy slope, grazing peacefully ; then we saw a single wild dog jump on to a rock only 100 metres below, quite unaware of us and looking intently at the sambar. Soon we picked out another ten dogs in similar attitudes forming a large semicircle on the upper side of the hinds. One of the dogs had eight little cubs, almost orange in colour, sitting behind her, presumably to be taught the technique of the game.

The ring of red dogs then moved downwards and inwards silently and steadily, tightening the half circle. The sambar were now aware and looked uphill but made no attempt to escape. As we watched the net tighten, two dogs suddenly went in to attack, and with a single high pitched excited yapping, separated off one of the hinds. One dog went for a back leg, presumably biting the tendon, and got kicked away—the only action she ever took to defend herself. The other jumped at her nostrils and tore them with his teeth and the blood flowed freely. The two dogs then sat down in the grass, making no attempt to pursue her while she limped rather slowly about 100 paces downhill. Here she stood dejectedly, with blood dripping from her nose, not making the slightest attempt to escape and apparently accepting the inevitability of death as the end to this grim drama. Equally the wild dogs were in no hurry. They knew the conclusion with certainty ; that they would be eating her shortly.

The other dogs, including the cubs, now moved down through the burnt grass and fanned out below the sambar hind. No communicating signals were heard ; perhaps because the ground was open with only an occasional tree and the dogs could always see each other and their prey. When the rest were in position below, the two dogs which had made the first attack, drove the hind downwards into the semicircle of those waiting below. All dogs now closed in with little noise and tore her to bits. This is by no means an isolated incident. I came across similar cases in other parts of India ; it is most necessary to shoot wild dog and so give sambar a better chance to increase.

Mudumalai and Bandipur Sanctuaries

No animal census has been taken in either sanctuary and only a few estimates are available. Elephant and Chital (*Axis axis*) are common and probably need cropping but a census must be taken first. The estimates of the large cats of Mudumalai are vague. They keep a ' Tiger/Panther sighting ' register, started on 1-xi-69, which showed for the first five months :—

Panther	..	14 sightings (5 of which were cubs).
Tiger	..	2 sightings (second one on 3-iv-70 when I was there and saw the pug marks).

Estimate on other animals :

Gaur	..	34

Estimate for Bandipur gave :—

Panther	..	8-10
Tiger	..	5 (2 males, 1 female, 2 three-month-old cubs in April).

These two sanctuaries were formerly famous for their Bison or Gaur. The present very low numbers of 50-60 are the result of a tragic outbreak of rinderpest, between August 1968 and February 1969, when 90% of the gaur died—probably about 1000 animals. Skulls now litter the two sanctuaries as a reminder of what can happen when there is no control of cattle infiltration—the undoubted spreaders of the disease.

The real cause of the rinderpest outbreak was not infiltration, but the regular driving each week of 100 to 120 head of cattle on a road through the middle of both sanctuaries, leading to their destination at Ootacamund. This practice was still continuing in August 1970, though proposals for trucking them or driving them through troughs of disinfectant have been put forward ; as well as a suggestion for teramycene powder to be added to ' salt-licks ' as a form of inoculation for the wild ungulates.

Besides Gaur (90%), Sambar suffered a 50% reduction, about 100, and Chital 5%, about 500. This state of affairs shows how necessary it is for the Central Government to take over all parks and sanctuaries and place them under a central Wildlife Department and Service.

The tiger figures need little comment. It is the same tragic state of affairs throughout India—poaching the tiger for the high price of skins—though the use of toxic pesticides, especially the colourless and odourless ' folidol ', seems greater in the south where there appears to be less control of distribution to the farmers. The big drop in tiger figures has been over the last five or six years and the whole State of Tamil Nadu is estimated to have only about 15 to 20 tigers.

Neither Bandipur nor Mudumalai has a ' Management Plan ' to refer to. Such plans are one of the most urgent needs. Poaching is difficult to control with so many villages in the vicinity, but the staff do their best.

Ranganathittu Bird Sanctuary

April was not the best time to visit. However some of the nesting species were starting to assemble and the variety was rewarding. In a row boat or coracle one approaches silently and good photos can be taken. More could be done to popularise this beautiful little sanctuary which is unknown to many tourists staying in Mysore City.

Periyar Sanctuary

No animal census has been taken but these estimates were given to me : Elephant 600 ; Gaur 500 ; Sambar 200 ; Pig 2000 ; Panther 15-20 ; Tiger 3 or 4 (the Asst. Wild life Officer saw one last in December 1969) ; Nilgiri Black Langur frequent.

This is one of the most splendid sanctuaries in India both scenically, with its combination of lake, grassland and forest, and zoologically as a viable eco-unit. It holds the greatest potential of all India's sanctuaries for a future first-class national park. But sadly it reflects in its administration the turbulent politics of Kerala with ever changing governments.

Tourist management is good with ease and comfort of viewing animals, especially elephant and gaur, from the motor launches which take visitors round the lake.

It is questionable whether any tiger remain, but Periyar could be a perfect situation for the re-introduction of this species. His natural prey is here—pig and gaur are plentiful and sambar would increase if allowed. It all depends on protection. Poaching is controlled with difficulty, due to few roads in hilly terrain and insufficient staff.

Grazing is minimal, being confined to a few cattle near the Tourist Lodges at one end of the lake. The whole sanctuary is therefore virtually free of the scourge which afflicts most of India's wildlife sanctuaries. There is no habitation, no cultivation and now no forestry operations. Some eucalyptus were planted near the dam but the Forest authorities have promised to do no more. Even the present plantations are not, to my mind, harmful as the trees are well spaced with plenty of grass beneath them, where I saw a group of elephant grazing.

The happy situation on grazing, cultivation and forestry operations in Periyar points again to its possible potentialities for the future. It is the largest of all Indian parks or sanctuaries and approaches nearest to the requirements of a true National Park. The situation is there, what is needed are the right men for the job.

Jaldapara Sanctuary

No animal census has been done, though Spillett (*JBNHS* **63**, 1966) did a count with estimates of most species. Since then Rhino have increased, though 1970 saw some unfortunate losses from poaching. This has at least had one good effect in that the administration has allotted seven more elephants around the sanctuary for both patrolling and sightseeing. (Chief Conservator, West Bengal, Jan. 1971).

Present estimates for animals at Jaldapara are :—Great Indian One-Horned Rhinoceros 74 ; Elephant 3 ; Gaur 8 ; Swamp Deer 3 ; Hog Deer 158 ; Sambar 34 ; Tiger 2 ; Pig 119 ; Muntjac 160.

This sanctuary, with the forest interspersed by typical riverine habitat of tall thick grass, is the perfect habitat for rhino and hog deer and protection should be concentrated on these herbivores. The tiger could never thrive in such a small curiously-shaped sanctuary.

There are no forestry operations, and there are no villages or cultivation within the sanctuary area. However there are many villages and a dense agricultural population bordering much of the sanctuary ; this results in considerable illegal grazing of cattle and buffaloes, and cutting of firewood and bamboo for hut construction. Law enforcement presents great difficulties for the sanctuary staff, especially in West Bengal with its high population density and political turmoil. However, they do a good job under trying circumstances and it is good news to know that more elephants for patrol work have been sent to help them.

The old Tourist Lodge at Baradabri is now largely ruined by the presence of noisy Army and Air Force personnel. The new Tourist Lodge at Holong, in the middle of the sanctuary, is beautifully designed and situated, built of wood and very comfortable.

Betla Sanctuary (Palamau National Park)

The small area of Betla (26 sq km or 10 sq miles) is the operative part of this proposed National Park. There is a high concentration of animals here, as shown by the figures of the census taken in May 1970 :—Chital 421 ; Sambar 38 ; Gaur 26 ; Pig 91 ; Muntjac 11 ; Tiger 2 (fresh pug marks) ; Panther 0 ; Hyena 1 ; Peafowl 48. The number of Chital is probably excessive for this area and culling will be necessary to prevent destruction of their own habitat.

In May, at the time of greatest heat and drought, there tends to be a concentration in Betla where better water holes, several of them man-made and maintained, attract animals. Population dynamics in Palamau as a whole have yet to be worked out, but the trend is migration into Betla in the drought and dispersal to other parts of Palamau and even out of the protected area in the seasons of more grass and water. The aim is to do a census in January and in May and so obtain a picture of seasonal movements. This is excellent and puts Betla well ahead of most Indian Wild Life Sanctuaries where the lack of regular censuses, if any at all, is regrettable.

Elephants are here in small numbers and their whereabouts is comparatively easy to determine in this open type of deciduous jungle. Their movements are the opposite of many other species between dry and wet season. They leave the Betla area in March or April to travel longish distances to the south in search of shade and water, returning north between July and October. Water they can get in Betla, but not the shade they need at the time of greatest heat.

The animal overcrowding in the Betla area when the heat is greatest is unhealthy and dangerous on two main counts : soil erosion and poaching. Provision of water holes in the areas adjoining Betla should be given high priority. Mrs. Anne Wright of Calcutta, who represents W.W.F. in Eastern India, has done excellent work in Palamau as a whole and Betla in particular. It is to be hoped that W.W.F. can find the money to assist in the making of several maintained and protected water ing places, so dispersing the animals and minimizing possible soil erosion and poaching. In the disastrous drought of 1967 many animals were killed by poachers. Now the Forest Service has an efficient system of regular patrols by Forest Guards combining anti-poaching measures with fire protection. This has proved effective in the Betla area where poaching is now minimal, but should be extended further in the other areas of Palamau.

There is no Management Plan for Palamau and one for the small area of Betla would have little validity since it is not a viable eco-unit. However recommendations have been made by Dr. Holloway (1970) of I.U.C.N. and hopefully one will be made.

Forty-three villages are situated on the borders of Palamau and, although all cultivation is outside the perimeter, 15,000 head of cattle graze legally within the sanctuary. The authorities, however, are fully aware of the danger of disease and have managed to have 13,000—all except young and pregnant cows—inoculated against rinderpest.

The cutting of bamboo, which goes on in many parts, undoubtedly causes much disturbance. Every night I spent in the forest I have notes of the noise of lorries and men's voices starting at 04.30 hours !

The Chief Conservator, who is a keen naturalist and photographer, is doing his best to find alternative resources of revenue for the State Forestry Dept. Contractors pay much money for this concession and, although the Forest Guards are vigilant, guns are sometimes found in the lorries. The forestry operations cannot be suddenly terminated, but the authorities are hopeful of gradual elimination. Equally they are trying to find alternative grazing areas for at least some of the cattle. Some eucalyptus have been planted, but this practice is now discontinued and only indigenous species will be planted in future.

A modern tourist lodge has recently been completed at Betla with four double rooms and bath, dining hall and lounge and catering facilities. When I was there at the period of greatest heat the electricity failed permanently resulting in no fans. Unless electricity can be assured it is better to have the old high-roofed Forest Rest House, one of which is available nearby. There are another four in other parts of Palamau. Two Mughal forts add to the beauty of the scenery. Several observation machans and hides are well placed near water holes. A jeep is available for visitors but one or two working elephants would be an asset.

Manas Sanctuary

This is a wild and beautiful sanctuary with great potential for future development. It has very few roads or even tracks and there well may be parts of it almost unknown. No census has been done and the following estimates must be viewed in the light of the statement above. The buffalo, rhino and elephant figures are probably fairly good estimates but others tend to exaggeration :—Wild Buffalo 400+, Elephant 350-400 ; Rhino 30-40 ; Gaur 150+ ; Tiger 35-45 ; Panther 2 or 3 ; Hog Deer common about 2000 ; Sambar 300 ; Barking Deer or Muntjac 500 ; Swamp Deer—a few remain, perhaps 20 ; Golden Langur 35-40 (mainly on the Bhutan side) ; Pigmy Hog 10-15.

Rhino have increased in the last five years. Poaching is minimal except along the southern borders of the sanctuary—the only part that borders on cultivation. The tiger figures seem high, but I was assured that they believe it could well be fifty, as they consider the tiger has increased in recent years ; this is quite possible in view of the inaccessibility of this sanctuary. The Pigmy Hog, once thought extinct, is apparently making a slow but steady come-back in this area. It is a shy nocturnal creature and it would be difficult to estimate numbers. Swamp Deer have declined in numbers and very few remain. The reason, other than poaching, is not known. The eastern part of Manas is so short of water in the very dry season that many of the animals leave. A man-made water hole and the reclamation of a silted-up pond near Uchila would be great assets.

There are no villages in this sanctuary, no cultivation and no forestry operations. In theory there is no grazing, but the villager's cattle on the southern boundary do stray into the sanctuary.

Visitors are very few to this superb sanctuary which combines such beauty of river, forest and hills with great numbers and variety of animals. The mahseer fishing is excellent and there is a wealth of bird life. If money could be spent on improving conditions for visitors and building some all-weather roads, this sanctuary could have a great future for wildlife and tourists alike.

Kaziranga Sanctuary

This well known sanctuary is rightly famous for its rhino and wild buffalo. The populations of both species appear to be in a healthy state with a good young : female ratio. E. P. Gee (1964) gave 375 rhino for Assam. The figure is now 450 at least. Considering the area of Kaziranga and the difficulty of any enlargement southwards into the Mikir Hills, it is quite possible that the present figures for these two species represent the maximum that can be carried, and they should not be allowed to increase further. A careful study is needed.

Present estimates of numbers, largely based on a census done on the block system in 1966, is :—Rhino 400 ; Wild Buffalo 550 ; Elephant 375 ; Gaur 20 ; Swamp Deer 250 ; Sambar 300 ; Hog Deer 4000-5000 ; Barking Deer 100 ; Wild Pig 500-600 ; Bear (Sloth and Himalayan Black) 30 ; Tiger 20-25 ; Leopard 12 ; Otter 200-300.

There is a constant danger of poachers for rhino horn, but the present Divisional Officer, who has a real love and knowledge of the sanctuary, takes the poaching hazard very seriously and he and the Wildlife Range Officer have their guards well organised.

The tiger figures are reasonably satisfactory, especially as they have risen slightly in the last few years. Admittedly this has not been proved by another census since 1966, but is the considered opinion of those officers and guards who have recently been observing the species together with a general increase in sightings. It should be a suitable habitat for tiger though more *Arundo donax*, their favourite tall grass, would be an advantage, and there are certainly plenty of pig and deer as natural prey.

Elephant numbers are high and are probably near their maximum for the sanctuary. They migrate, at flood time, into the Mikir Hills and cross the Grand Trunk Road on the southern edge of the sanctuary at points where it runs through continuous forest.

There are no forestry operations and no cultivation within Kaziranga, but the question of grazing still hangs in the balance. The situation has improved greatly since Spillett's survey in 1966 (loc. cit.). When I was there in May 1970, there were still about 2000 cattle and domestic buffalo grazing over about 3 sq km on the edge of the sanctuary in the Kaziranga block. The Divisional Officer was hopeful of finding alternative grazing for them but, as so often, political forces may find such an arrangement inconvenient and the true National Park may never materialize. It is pointless to have the name without effective legal power to operate it.

But this is a magnificent sanctuary, and nothing should detract from the splendid work done in the past (Assam Forest Records show that a Rhino Reserve was first formed in 1907 when rhino numbers were down to 30), and the present by a handful of dedicated men. The Divisional Officer, most ably supported by his Wildlife Range Officer, is carrying on in the tradition of a famous predecessor, R. C. Das, who in the early fifties with P. D. Stracey at the top as Chief Conservator, and E. P. Gee at hand to advise, put Kaziranga on the map, controlled poaching and greatly increased the numbers of all animals in the sanctuary. India was lucky to have such men at that critical time for the rhino and Kaziranga. It still has them, and the present staff overall are the keenest and most dedicated I have come across in India.

Kaziranga can have a great future and, by reason of its habitat and species, can combine most happily wildlife orientation and development with tourist attractions. Animals can be seen easily and comfortably in their natural surroundings, and although the sanctuary itself is flat, the backdrop of the snow-covered peaks of the Himalayas in the cold season gives a fabulous setting.

The tourist facilities at Kaziranga rank with Periyar and Corbett as the best in India's Wildlife Sanctuaries.

Kanha National Park

The wildlife management at Kanha is good. The same cannot be said of the tourist management ; in fact the less said about it the better. The authorities concerned at Kanha and in Delhi are now well aware of the situation and I feel sure some radical improvements have been made since the disastrous state of affairs which I encountered in June 1970.

Kanha alone of National Parks and Sanctuaries has carried out a regular yearly census of animals. The figures for 1970 (June), done on the block system, are given without comment : Gaur 478 ; Chital 4035 ; Sambar 235 ; Barasingha 66 ; Muntjac 105 ; Mouse Deer 12 ; Blackbuck 78 ; Four Horned Antelope 8 ; Nilgai 6 ; Tiger 34 ; Panther 13 ; Hyena 22 ; Sloth Bear 23 ; Wild Pig 497 ; Porcupine 14 ; Wild Dog 28 ; Jackal 45 ; Fox 90 ; Jungle Cat 30 ; Peafowl 639 ; Hare 66 ; Python 1.

The visitor probably has more chance of seeing Tiger in Kanha than in any other park or sanctuary in India, with the probable exception of the Corbett Park in Uttar Pradesh. Here in Kanha the average density is one tiger to 3·5 sq miles, in Corbett 1 to 4·5, in Kaziranga 1 to 8·5 and Palamau 1 to 16. So not only is the density greater but the forest, especially the Sal, is fairly open with little undergrowth, so tiger can be seen in daylight.

There are no forestry operations, and no cultivation after the successful removal of a complete village to a new site outside the park. This is a considerable triumph of persuasion and administration.

The amount of grazing is not serious and consists mainly of cattle and buffalo belonging to the Forest Guards and their relatives living near the main entrances. Nevertheless these total about 2000 head, admittedly on the periphery of the park, but many of the herbivores leave the grasslands in the rains and barasingha might pick up disease by contact with these cattle.

The easy viewing of animals on the open grasslands is ideal for the average tourist. The dry weather airstrip at 1000 metres, sufficiently on the edge of the park not to cause animal disturbance, could be a great asset to this otherwise rather inaccessible park, whose future can be great given a strong hand on the administrative rudder.

Sariska Sanctuary

Sariska has great potential for an excellent National Park with easy accessibility from the capital, Delhi, which makes it unique.

But India's foremost problem—the cow—is more in evidence here than in almost any other sanctuary. If this major problem could be solved Sariska could carry larger numbers of wildlife than it has today, in spite of over half the area being rocky barren hilltops with little or no soil and precipitous cliffs. Scenically however, these add to its beauty and their ruggedness is a splendid contrast to the better watered green valleys.

No census has been done but these are the estimates for 1970 :— Nilgai 375 ; Four Horned Antelope 170 ; Sambar 350-400 ; Chital 100+ ; Indian Gazelle 6 ; Wild Pig 250 ; Tiger 12 ; Panther 14 ; Caracal 7 ; Hyena 10 ; Jackal 150 ; Peafowl 2000+.

The number of tiger is small, but in the very dry weather there is a good chance of seeing them as they are localised near water. In five days I had evidence of 4 separate animals. A nilgai killed by a tiger had been eaten normally from the hindquarters, but also quite separately from a flank. This could indicate a tigress and cubs.

Four nights were spent by a water hole which is man-made and maintained. The Khalighati Observation Tower is certainly one of the most fruitful and effective, especially in the hot, dry weather, of any in India.

Exploitation of the sanctuary's forests continues ; mainly *Anogeissus pendula*, *Boswellia serrata* and *Acacia nilotica* bring in considerable revenue to the Forest Dept. which it cannot at present forego.

One village has been completely removed outside the sanctuary, but there are still several small ones with little patches of cultivation around. There are public roads through Sariska but poaching is not a big problem.

Grazing is easily the worst scourge. Cattle, buffalo and goats are everywhere in the valleys. These are not just the animals of a few villagers or dependents of the sanctuary staff ; they belong to professional graziers who pay up to Rs. 10 per head in certain areas. The sanctuary is badly overgrazed by many thousands of cattle.

In the ancient geological series of the Aravalli there are bound to be mineral deposits. Often they are too dispersed for mining to be an economic proposition ; but copper veins are already being worked on the edge of the sanctuary and nickel has been discovered.

Good mineral deposits in economic quantities are bound to have preference over wild life and a part of the sanctuary will have to be shifted if such deposits are found. This could be done without too much harm and is inevitable, but the question of leasing the sanctuary to professional graziers is surely something that could be gradually phased out.

This sanctuary could then have a great future with easy access from Delhi.

Dachigam and Desu

The main purpose of my visit to Kashmir was to get some information on the Hangul or Kashmir Stag. It is estimated that there may be about 200, plus or minus 30, in Dachigam, with perhaps 100 elsewhere in Desu in the Bring valley, and Chumkai, Overa and Khiram in the Liddar valley as well as in some of the valleys between. These last three are very small sanctuaries (5-15 sq miles each).

The Sheep Research Station, started in 1962, whose headquarters is situated right in Lower Dachigam sanctuary, take their sheep to the upper pastures from mid-June to the end of September. This inevitably causes disturbance to the hangul as there were about 1200 sheep grazing over Upper Dachigam when I was there. The superintendent of the Sheep Research Station maintains that his men do not poach (they are better paid than the Forest Guards) and even form a buffer zone of protection for the hangul against the lawless ' bakrewallas '. I think there is some truth in this, but it is unfortunate nevertheless that a Government Sheep Research Station should have been deliberately sited in the best part of the lower sanctuary. It would be possible to shift their summer grazing grounds to other suitable alpine pastures on the plateau of Sangergulu in the same area, but outside the sanctuary. This would have the double advantage of leaving Upper Dachigam free for the hangul and acting more effectively as a buffer zone against many ' bakrewalla ' villages.

If this could be done it would be a great step to conserving the hangul's habitat. At present the deer are being driven higher up than they usually go and even out of the sanctuary by the disturbance of the sheep, the shepherds in their tents and their dogs. Even so, some hangul come regularly to the stream in this upland valley and I saw twenty to thirty recent tracks leading to water.

In Desu, there is a similar situation with experimental potato plots at intervals up the valley in clearings between the conifers and the river. It appears that the potato experiment has not been successful and it is probable that the land will be handed over to the Animal Husbandry Dept. for a Sheep Research Station, similar if smaller to that of Dachigam, to be sited within the sanctuary.

At the moment there seem to be a fair number of hangul for such a small area (Desu—52 sq km). From observation of tracks and information I would make a rough estimate of 30-35. The future however for this beautiful little sanctuary is not bright. 50+ cattle were seen one morning through field glasses at about 3000 m (10,000 ft) and on questioning I was told that they often stray from villages outside the sanctuary and what can be done about it with only two forest guards available !

So with sheep in the valley and cattle on the heights there will not be much room for hangul. The economics of the situation has got to be accepted ; one hangul earns nothing, unlike one tiger in Madhya Pradesh or one rhino in Assam, whereas one sheep earns much for the Government of Jammu and Kashmir.

Cattle, sheep and hangul may well have to live together. If they cannot, it is clear which has the precedence in an overcrowded country with an expanding economy. In Dachigam it is different ; there the hangul are concentrated in a comparatively small area on the valley floor of Lower Dachigam in the winter months, and tourists can drive out the short distance from Srinagar to view the deer from several well-sited observation towers. Desu should still remain a sanctuary with such protection as is possible given to the animals (e.g. musk deer and marmots at higher levels), but would become more like the National Parks of the UK, places of great scenic beauty with their flowers, trees and birds, where the tourists can come for day trips to picnic or stay in a hotel.

Bharatpur Sanctuary

This sanctuary is best known for its birds, and is one of the finest waterbird sanctuaries in India. It is often not realised that it also carries a fair number of chital, blackbuck, nilgai and a few sambar. These mammals are found in the thorn forest and grassland region which covers roughly half the area.

The numbers of water birds are enormous at nesting time (August, September) with a rich profusion of species, well known to all those interested. Many birds, especially openbill storks, will not nest until they feel the safety of water around the base of their tree. Small man-made islands are now being built with an acacia tree on top of each to facilitate the safe nesting of more birds. This is an excellent idea and demonstrates the care and interest with which the sanctuary staff and the D.F.O. look after the birds.

This small sanctuary is surrounded by villages and, although there is no cultivation within the sanctuary, the villagers graze 6000 head of cattle and buffalo there; the consequent overgrazing and erosion by trampling is very bad indeed. There are even 80 feral cattle and some of the bulls have become quite fierce. Nothing can be done about this as no one may touch the 'sacred cow' and no one will drive them out as they are too wild. Poaching is considerable as the cultivated land comes right up to the sanctuary boundary.

In spite of all these difficulties, Bharatpur remains a magnificent bird sanctuary and very accessible from Delhi; the journey by train takes only three hours to Bharatpur. With this ease of access it could become a great tourist attraction. If grazing could be controlled or better still eliminated, then this sanctuary could carry many more herbivores and, in turn, attract more tourists and more money.

Corbett National Park

Elephant and crocodiles are the only animals covered by a census, in 1967 and 1969 respectively. The rest are *estimates* by the park staff:—Elephant 38; Crocodile 29; Gharial 15; Chital 8000; Hog Deer 200; Sambar 500; Muntjac 500; Tiger 40-50; Panther 50; Himalayan Black Bear 20; Sloth Bear 30; Wild Pig 2000; Goral 50.

The Inspector-General of Forests kindly arranged for me to visit it in the monsoon, when visitors are not normally allowed; two elephants were made available to carry our party, consisting of the Wildlife Warden Park Officer, myself and servants and equipment, the 30 kms from the entrance to Dhikala Tourist Rest House. Apart from being the only visitor, the advantage of going in the rainy season is the ease with which indirect but substantial evidence can be gained of tiger from the very clear fresh pug marks after a rain shower.

The Warden estimates that as many as 10 to 12 of the park's 40 to 50 tiger can usually be found within a radius of 8 kilometres (5 miles) of the Rest House at Dhikala. He told me that live bait are tied up during the tourist season, but that beats for tiger by elephant are not normally held more than twice a week to avoid too much disturbance. Even so he reckons 25% of tourists to Corbett saw a tiger in the last two years, based on numbers of visitors in their books ; but of course many only stay two or even one day. Assessing this another way, I would put the chances in Kanha at 10% (i.e. if a visitor stays ten days he would be very unlucky not to get one viewing), while those in Corbett I put at 20% (i.e. if a visitor stays for five days he would be unlucky not to view once).

Panther are estimated at similar numbers to tiger (40-50) and appear to co-exist satisfactorily. Indirect evidence from pug marks was obtained near the Tourist Rest House and one afternoon I disturbed a panther stalking chital only half a kilometre from there.

The Kalagarh or Ramganga Dam is certainly a threat to some of the species in the park, notably chital and hog deer. The reservoir will cover 83 sq km (32 sq miles) of which 46 sq km (18 sq miles) are within the park boundary. 46 sq km is not a large slice out of the Corbett Park as a whole, but is much more serious when it is realised that the water will submerge nearly all the riverine habitat where most of the hog deer are found and tiger often seen, while a large proportion of the rare grasslands to be found in the park will also be lost. It is on these grasslands near Dhikala that visitors are shown regularly from observation towers large herds of chital as well as sambar, hog deer, pig, elephant and sometimes tiger and panther. Two-thirds of this excellent viewing area will be lost ; in all 900 acres of grassland out of a total 2000 in the park. It was estimated (Spillett 1966) that 2300 chital use the area to be submerged.

The reservoir is already gradually filling and it is therefore fruitless to dwell too much on the disadvantages. It will be full sometime in 1972. Let us consider instead some advantages that may be gained. From the tourist point of view it will undoubtedly add to the scenic beauty of that part of Corbett and the view from the Dhikala Tourist Rest Houses, already magnificent, will be enhanced by a great sheet of water, only 25 metres below the Rest House parapet, encircled by forested hills. This, in my opinion, will be the finest panorama to be seen from any Tourist Rest House in an Indian park or sanctuary, not excluding Kaziranga backed by snow mountains or the lake of Periyar.

Perhaps the greatest advantage will be the facilities afforded by this great sheet of water for viewing animals from tourist launches as in Periyar. At Corbett the authorities have benefited from the experience at Periyar and are felling the trees before submersion takes place. This will wisely avoid the unsightly tree trunks which now project from the water all round the Periyar lake when the level is low.

The animals to be viewed by this method in Corbett may not be so varied or numerous as in Periyar; elephant are few and there are now no gaur, but sambar and pig would be seen as well as chital, while crocodile and gharial might be viewed when sand banks appear at the upper end of the reservoir as easily as crocodiles in the Murchison Falls Park in Uganda.

As regards the grassland area or ' chaur ', attempts will be made to compensate for the loss of much of this valuable viewing area by clear felling stands of poorer sal mixed with less useful trees on flat land, thus creating new pockets of grassland. Preferably this will be done on the forest edge of the remaining grassland so that eventually the area of this habitat will be no less than it is at present. Pockets of such grassland extending into the forest might be even better for animal viewing than the existing area since the shyer animals, if attracted by salt licks and water, will more readily come into a relatively small open area with the forest cover nearby.

A 30 km fair weather road connects the main tourist centre at Dhikala with the park entrance at Dhangadhi. This road is cut by the arrival of the first heavy rains in mid-June. It has to be re-made after the rains have stopped in September ; this takes at least a month of much labour by many workmen and no tourist can be admitted until November. The suggestion for tarmacing this road is, to my mind, unnecessary and involves an astronomic cost.

The road was motorable between the torrents and these need only Irish bridges, which could be built at a modest cost, to keep it open for part of the monsoon. There had been no rain for several days when we entered the park and, if the torrent beds had had the concrete causeways suggested, then I consider we could have got through by jeep with only the occasional large boulder to be cleared from our path. The rocks could be cleared with the minimum of labour as soon as the torrents had ceased to be violent at the end of August or early September, thus facilitating an earlier opening. With such causeways it would not be necessary to close the Corbett Park for the whole 5 months from June to November.

Notes on some Kashmir Birds

BY

F. M. GAUNTLETT

Observations were made during a brief visit to Kashmir in August/ September 1969. These are compared with the data in Bates and Lowther 1952. It appears some wetland species have declined or vanished, and others more dependant on man may have increased. Several observations made by other observers around Gulmarg are confirmed.

Col. R.S.P. Bates and E.H.N. Lowther published in 1952 the results of 16 summer visits to Kashmir between 1920 and World War II and summarised the observations of earlier ornithologists such as Meinertzhagen, Osmaston and Ward *et al.* There has not been much ornithological work in Kashmir since.

Bates and Lowther (to be referred to as B & L henceforth) urged other ornithologists to publish their results and having received considerable advice from Col. Bates in my early days, I feel I owe it to him to do so. I also hope it will encourage others to do so and show that worthwhile observations can be made even on a family holiday without having to organise a major expedition.

I arrived in Kashmir on 26th August and left on 5th September 1969. In this brief time it was obviously impossible to cover a large amount of ground in detail and many places could literally only be given a casual glance. Nevertheless, half the number of species listed by B & L and almost two-thirds of those they found nesting were identified.

It was not an ideal time of year for an ornithological investigation because many summer visitors have left the Vale by mid-Sept. and only reduced numbers could still have been present and also many species which are located mainly by sound such as owls and cuckoos were silent. Also, during the breeding season most small birds are fairly evenly distributed in nesting territories in which they tend to advertise themselves, but at this time of year they band together in large mixed flocks and a forest can appear completely deserted until one of these roving bands passes through when the observer is overwhelmed for a few minutes until it moves on. The season is also too early for many high altitude species to be expected at a lower level.

B & L's observations are now between 30 and 50 years old but even then the pressure of human population was having its effect on

Whiskered Terns on the Dal Lakes and the Ibisbill (*Ibidorhyncha struthersii*) had disappeared from the Lidar valley.

I have no data for the population of Kashmir at that time but it has no doubt increased in step with that elsewhere in India, particularly in Srinagar (population 285,000 in 1961). I was told 10,000 people now live in houseboats on the Dal Lakes and saw no reason to disbelieve it.

What was once marsh and forest in the Vale has given way to rice fields and orchards. There was no sign of the well wooded area in the Sind river delta to which B & L referred.

My visit was divided into two parts: Firstly centred on Srinagar with trips in the Vale and some of the side valleys, and secondly at Gulmarg for higher altitudes.

The base for operations in Srinagar was the Palace Hotel, just outside the town to the east of Takht-i-Suleiman, or Shankar Acharya Hill. This was a fortunate choice ornithologically because it was situated in its own large garden in which most meals were taken alfresco for minimum interruption to bird-watching. There was also a golf course sloping down to the edge of the Dal Lake. A spur of hills running out from the main rim of the Vale rose right from the back of the hotel.

Detailed maps are unobtainable and data to describe the areas visited has had to be culled from a number of sources, some of them conflicting.

Altitudes are given with the dimension in feet first to avoid the ridiculous situation of figures rounded to the nearest 1000′ being quoted to 4 significant figures metrically. For approximate elevations the conversion has been taken as 1000′ = 300 m; for precise elevations, 1000′ = 304·8 m.

The floor of the Vale, including Srinagar, lies at about 5100′ (1530 m). Apart from Srinagar itself visits were made to places in and around the Vale as follows:—

26–8–69 Takht-i-Suleiman, or Shankar Acharya Hill 6210′ (2040 m just on the edge of Srinagar. A brief visit up the new road being cut up the hill, to about 5800′ (1740 m). A rather dry scrubby hillside with a pine wood on the eastern slope.

27–8–69 (*a*) The Mogul gardens of Chashma Shari, Nishat Bag and Shalimar Bag.
(*b*) By boat on the Dal Lakes, floating gardens and backwaters of Srinagar.

28–8–69 Dachigam Nullah. By car to the former hunting lodge, recently burnt down, then on foot 2 or 3 miles (3-4½ km). The floor of this narrow steep-sided valley lies at about 6000′ (1800 m) and is well wooded with broad-leaved trees along the banks of the nullah. This particular locality does not appear to have been worked by B & L themselves.

29-8-69 (*a*) A round trip of the northern part of the Vale by car taking in Manasbal, Ganderbal and Wular Lake.

(*b*) An evening visit to Pari Mahal. This is an overgrown Mogul ruin about 1 km east of the hotel. It is at an elevation of about 5500′ (1650 m) on the lower slopes of the spur running out from the rim of the Vale.

30-8-69 The slope above Pari Mahal to the summit of the spur at about 7500′ (2250 m). Mostly dense thorny scrub with scattered pine woods higher up and grassy summit ridge.

31-8-69 Up the Sind valley by car to about 2 km short of Sonamarg, elevation approx. 8500′ (2550 m). About 2 hours spent in the pine woods near the mouth of Glacier Valley. The rather birdless Sind river runs through magnificent scenery which will be drastically changed when the various hydro-electric schemes are finished in a few years time.

Gulmarg was the centre for operations from 1-9-69 to 4-9-69. It is situated at about 8300′ (2490 m) on the Pir Panjal mountains which rise steeply from the west side of the Vale. It is a gently undulating meadow surrounded by fir woods. From Gulmarg, fir clad slopes rise to Killenmarg at about 10,500′ (3150 m). This is a rather rock strewn meadow with some extensive bushy areas near a stream. From here steep slopes lead up to the summit ridge of Aphawat at 13,592′ (4143 m). The lower few hundred feet (c. 100 m) of the Aphawat slopes are covered with birch (*Betula* sp.) and rhododendron scrub.

There is a stream or nullah which rises on the slopes of Aphawat flows across Killenmarg and down through the fir woods to Gulmarg, across the meadow and leaves at the northern end through a spectacular gorge. The mouth of the gorge where the stream emerges into the Vale can be reached by a bridle path which goes through Babarishi, elevation approx. 7000′ (2100 m).

The main ornithological activities were concentrated on the slopes between Gulmarg and Killenmarg along the stream, and up to about 13,200′ (3960 m) on Aphawat on 2-9-69. A trip was made to the mouth of the gorge below Babarishi on 4-9-69.

SYSTEMATIC LIST

The order of the list follows that in B & L 1952 for easy comparison with that work but the nomenclature is that of Ripley 1961, with the names in B & L given as well where these differ (ignoring small changes in spelling). Almost one-third of the Latin names have been changed which is a fair indication of just how firm and universal such names actually are.

Following the current trend in field ornithology, the list is based on species and not sub-species. The latter are almost impossible to tell apart in the field, are of doubtful validity in some cases according to different experts, and particularly in India, represent only an arbitrary segment of a cline from one extreme to the other. This has meant dropping a number of regional adjectives such as 'Indian', 'Kashmir', 'Himalayan' etc. from the English names of B & L.

Corvus macrorhynchos Jungle Crow

B & L found it common in all the well-wooded areas away from the centre of the Vale.

I found it in Dachigam Nullah and near Sonamarg. It was excessively common around Gulmarg where it has adopted all the parasitic habits of the House Crow. This is not its sole source of sustenance because I found several at Killenmarg apparently catching small lizards sunning themselves on large boulders.

Corvus splendens House Crow

B & L stated it was not particularly common even in Srinagar and had declined since 1920 but was probably increasing again.

It is now a common bird in Srinagar but is still outnumbered by the Jackdaw by a factor of at least 3 or 4. The increase suspected by B & L has obviously taken place to a substantial degree.

Corvus monedula Jackdaw

Stated by B & L to be exceedingly numerous in the towns and villages of the Vale, less so in the side valleys.

It is still the common urban crow of the Vale but may have lost ground to the House Crow in Srinagar. The increase in size and population of the town has probably offered increased opportunities to both species.

Nucifraga caryocactes Nutcracker

Large Spotted Nutcracker *N. multipunctata*

The status of this species is not clear from B & L. They say it is commonest in Kashmir compared to the rest of its range but it appears they did not have much first hand experience of it, and the Kazinag range is the only area from which they give specific records.

I found it in the fir woods just below Killenmarg and also below Babarishi. It is thus fairly common around Gulmarg between 6000 and 10,000′ (1800-3000 m).

Pyrrhocorax pyrrhocorax or **graculus** Chough sp.

Both the Redbilled and Yellowbilled (or Alpine) species were found to be patchily distributed at high altitudes by B & L.

A pair of birds were seen circling near a precipitous crag towering over Dachigam Nullah to the north (possibly Mahadeo). Due to the more sociable nesting habit of the Yellowbilled, I am inclined to think they were Redbilled. Aphawat which is without steep crags is not to the liking of either species apparently.

Parus major Grey Tit

B & L found it comparatively common up to about 7500′ (2250 m).

I came across only two birds in the Chenar trees in the mogul gardens and a few in Dachigam Nullah. It was less common than I expected.

Parus melanolophus Crested Black Tit

Lophophanes melanolophus

Stated by B & L to be widely distributed from 5000′ (1500 m) to 11,000′ (3,300 m).

I saw this species in a small pine wood above Pari Mahal and found it common around Gulmarg up to Killenmarg.

Parus rubidiventris Rufousbellied Crested Tit

Simla Black Tit *Lophophanes rufonuchalis*

A similar distribution to the previous species according to B & L.

I found it near Sonamarg and also around Gulmarg, often in company with the preceding species. I agree with B & L that there is not much to choose between the relative numbers of the two, at least so far as Gulmarg is concerned.

Sitta europaea Common Nuthatch

Brook's Nuthatch *S. caesia*

Found by B & L between 6500′ (1950 m) and 9000′ (2700 m) mainly from 7000-9000′ (2100-2700 m) and say it was ‘particularly numerous in the woods bordering the Wular Lake’. There are certainly no woods bordering the Wular Lake today, unless the willow (*Salix* sp.) scrub can go by that name. Land around the north shore which may once have been woodland is now mostly paddy fields and the steeper slopes are rather dry and bare. B & L statement is rather odd because Wular Lake is well below the lowest level they have given for the distribution of this species. They also say Osmaston found it less numerous than the next species around Gulmarg.

I only came across it at Gulmarg where it was seen quite frequently, usually in a mixed flock with tits etc.

Sitta leucopsis Whitecheeked Nuthatch

Generally distributed in somewhat smaller numbers than the last in forests between 7500′ and 10,000′ (2250-3000 m), according to B & L.

I found it only at Gulmarg where, contrary to Osmaston, it was less frequently seen than the last. It is a demonstrative species fond of exposing itself at the tops of tall trees and should be readily observable. It appears to have lost ground.

Garrulax variegatum Variegated Laughing Thrush Negative

Trochalopteron variegatum

'Almost entirely confined to the belt between 7500′ and 11,000′ on the inner slopes of the Pir Panjal mountains . . . . Here it is a widespread and common bird'. B & L go on to quote Osmaston who said it was not found at Gulmarg but was not rare in the birches and rhododendrons on the slopes of Aphawat between 10,000′ and 11,000′ (3000-3300 m).

This habitat was searched without success on two occasions, but it is so dense a determined skulker could easily escape notice. These are generally noisy birds but may be less so after the breeding season, and they could have already dropped down to lower levels.

Garrulax lineatus Streaked Laughing Thrush

Trochalopteron lineatum

B & L found it a common bird in the undergrowth and scrub on the slopes around the edge of the Vale up to 8500′ (2550 m).

I came across two birds in dense scrub above Pari Mahal and 3 or 4 in a large mixed flock in the shrubs and undergrowth in and around the garden of my chalet at Gulmarg.

A field character clearly noted on the latter birds and not mentioned in the reference books was a distinct golden yellow tinge to the primary feathers, which at first suggested they may have been the previous species, but several minutes careful observation showed they had no other significant markings except broad grey tips to the tail feathers and indicated they were undoubtedly this species. The golden yellow tinge may be a feature of fresh autumn plumage.

Hypsipetes madagascariensis Black Bulbul

Microscelis psaroides

At this time of year would only be likely to be found in the well wooded portions of the side valleys, from B & L.

This indeed was the case and I found it common in the Dachigam Nullah.

Pycnonotus leucogenys Whitecheeked Bulbul

Molpastes leucogenys

B & L found it exceedingly common throughout the Vale and a short way up the side valleys.

I found it to be a common garden bird around Srinagar and also up Dachigam Nullah.

Certhia himalayana Himalayan Tree Creeper

B & L say it was a common bird in forests from 6500′ (1950 m) upwards, most numerous in firs between 8000′ and 9000′ (2400-2700 m).

From this it appears Gulmarg should be an ideal place for it, and I found it a common bird there.

Troglodytes troglodytes Wren

B & L found it common in broken ground from 8000′ (2400 m) to above the tree line.

The only one I saw was in low alpine vegetation at about 12,000′ (3,600 m) on a rocky slope of Aphawat.

Cinclus pallasii Brown Dipper

A common bird of the side streams up to 10000′ (3000 m) according to B & L.

I found it common only along the nullah between Gulmarg and Killenmarg and also where the same nullah leaves Gulmarg meadow. Despite a careful search at several likely points along the Sind river I did not find it there, or along Dachigam nullah. It is possible the birds may move to higher levels as the summer progresses.

Erithacus brunneus Bluechat

B & L say it was a common bird in dense undergrowth between 6000′ and 9000′ (1800-2,700 m).

It is such a renowned skulker identified mainly by voice I count myself fortunate in having good views of one on the shady path along Dachigam nullah. Possibly overlooked elsewhere.

Hodgsonius phoenicuroides Whitebellied Redstart

Hodgson's Shortwing

A common bird of scrub between 8000 & 10,000′ (2400-3000 m), according to B & L who quote Osmaston as finding it common in and above Gulmarg.

The undergrowth in the open fir woods between Gulmarg and Killenmarg appears to be to the bird's liking because several times I saw the flash of orange on the tail of the shy skulking bird as it dived into a bush.

Saxicola torquata Stonechat

B & L found it exceedingly numerous on the barer slopes round the rim of the Vale, commonly up to 8000′ or 8500′ (2400 or 2550 m).

This was indeed the case all the way up to the summit of the slope above Pari Mahal. It was also common in open ground in Dachigam nullah. I also found it common in the garden around the hotel. This is a habitat to which B & L do not refer. The birds had probably moved in from the dry slopes nearby. Like Osmaston, I did not encounter it at Gulmarg which is probably too lush for it.

Enicurus maculatus Spotted Forktail

Negative. It could be inferred from B & L that this is fairly common species on the side streams on the slopes around the Vale.

Despite a careful look at every opportunity at streams large and small, I never saw it. One can only conclude that it is less common than it was or that, at best, it is very local.

Chaimarrornis leucocephalus Whitecapped Redstart

A common bird of streams from 8000-12,000′ (2400-3600 m) according to B & L, at least from June onwards.

It was common on the nullah between Gulmarg and Killenmarg and also at the gorge at the exit from Gulmarg meadow, I did not find it on the Sind river or Dachigam nullah, both of which would be too low for the species at the time of year.

Rhyacornis fuliginosa Plumbeous Redstart

B & L say it was numerous on every river and torrent in Kashmir up to 9000′ (2700 m), but absent from the main Vale.

Apart from one on the Sind river at the narrowest part of the gorge, I found it common in the same localities as the previous species.

Erithacus pectoralis Himalayan Rubythroat

Calliope pectoralis

A bird of the slopes beyond the tree line, according to B & L, up to 13,000′ (3,900 m).

A bird with typical behaviour of the genus and characteristic white supercilium and chin of the female or immature of this species was seen in a small patch of abandoned cultivation near Babarishi, approx. 7000′ (2100 m). It had probably dropped down from higher up on its way to winter quarters. The bushes and boulders at Killenmarg appeared to be a likely habitat but none were seen there.

Erithacus cyanurus Redflanked Bush Robin

Ianthia cyanura

B & L say it was common in heavier forests between 8500′ and 11,000′ (2550-3300 m) and quote Meinertzhagen as abounding at Gulmarg between 6400 and 8600′ (1920-2580 m) in September.

I found this bird in the shrubs along the banks of the nullah between Gulmarg and Killenmarg. 5 seen in one day may be considered ‘ abounding ’ for this rather retiring species.

Phoenicurus caeruleocephalus Blueheaded Robin

Adelura caeruleocephala

A rare bird of rocky hillsides between 9000 and 11,000′ (2700-3300 m) according to B & L.

It was thus surprising to find a female or bird of the year skulking in a flowerbed in the garden of my chalet at Gulmarg one day. The pale eye ring was a very distinct feature in the field.

Turdus unicolour Tickell's Thrush

I found it a common bird of gardens and lawns around Srinagar and it had a particular liking for fallen fruit in the Mogul gardens. It was also present in Dachigam nullah. This does not differ from what one would have expected from B & L.

Turdus viscivorus Mistle Thrush

Arceuthornis viscivorus

‘ Not particularly common . . . distributed from 7000′ (2100 m) upwards.’ B & L.

I saw a flock of six at Killenmarg flying from the birches to the fir woods lower down. This is in accordance with B & L on the birds' post-breeding season behaviour.

Monticola cinclorhynchus Blueheaded Rock Thrush

B & L found it not uncommon in well wooded areas from 6000-9000′ (1800-2700 m).

I only found it in Dachigam nullah, near the former hunting lodge.

Monticola solitarius Blue Rock Thrush

‘ Not uncommon on treeless and stony slopes, more numerous between 5000′ and 6000′ ’ (1500-1800 m), from B & L.

I did not examine the slopes around Wular Lake which are supposed to be its headquarters, but did find it on the Takht (Shankar Acharya Hill) where B & L said it ought to be.

Myophoneus caeruleus Whistling Thrush

According to B & L, widely distributed up to 10,000′ (3000 m) but absent from the centre of the Vale.

I found this bird quite common along the nullah between Gulmarg and Killenmarg.

Prunella strophiata Rufousbreasted Accentor

Jerdons Accentor

'Very numerous at high elevations throughout the area. . . down to as low as 8000′.' (2400 m), from B & L.

I found one at the summit of the slope above Pari Mahal *c*. 7500′ (2250 m), one in bushes at Killenmarg 10,500′ (3150 m) one in a mixed flock near by chalet at Gulmarg 8300′ (2490 m) and a possible, though it seemed darker than others of this species, at about 12,000′ (3600 m) on Aphawat. The view was too brief to be certain whether it was this or another species. I did not find it as common as B & L made out, but it appears to extend to lower levels after the breeding season.

Muscicapa sibirica Sooty Flycatcher

Hemicheldion sibirica

B & L found it widely distributed in forests from 7000-11,000′ (2100-3300 m), its stronghold is between 8000-10,000′ (2400-3000 m).

It was certainly very common around and above Gulmarg, but I also found it in Dachigam nullah and even in gardens at the edge of the Dal Lake, so that some were already on their way to winter quarters.

Muscicapa subrubra Kashmir Redbreasted Flycatcher

Siphia hyperythra

Ripley considers this a subspecies of Redbreasted Flycatcher *M. parva subrubra* but I follow B & L and Voous in considering it a separate species. It has a distinctive male breeding plumage, distinct breeding and wintering area and yet migrates through areas occupied by other forms.

B & L found it fairly common in well wooded areas up to 7500′ (2250 m).

I found it in the pine wood on the Takht and in Dachigam nullah which agrees with this. The males were still in summer plumage, yet B & L say they leave for winter quarters in September.

Muscicapa leucomelanura Slaty Blue Flycatcher

Muscicapula tricolor

According to B & L, a common bird in forests up to 10,000′ (3000 m) outside the rim of the Vale, particularly numerous between 6500 and 9000′ (1950-2700 m).

I came across it once in Dachigam nullah and occasionally at Gulmarg. This is apparently less common than B & L indicated, but it is very skulking for a flycatcher.

Muscicapa superciliaris Whitebrowed Blue Flycatcher
Muscicapula superciliaris

B & L found it from 6000′ (1800 m) to almost 10,000′ (3000 m) and commonest at 7000 or 8000′ (2100 or 2400 m).

I saw it once only, in Dachigam nullah. It is possible the birds were already moving out to winter quarters.

Muscicapa ruficauda Rufoustailed Flycatcher
Alseonax ruficaudus

Widely distributed in forests up to 9000 or 10,000′ (2700 or 3000 m), a most numerous bird in the lower portions of the side valleys. In fact, B & L go on to say it was without doubt the commonest flycatcher at lower and medium elevations.

I cannot agree with this, because I only saw it once, again in Dachigam nullah. It seems likely the species is an early migrant and the majority had already gone.

Terpsiphone paradisi Paradise Flycatcher

Common in the summer months in the main Vale. Few pairs penetrate the lower side valleys, from B & L.

This species becomes very scarce in West Bengal after the end of August and must also leave Kashmir at about the same time because once again, Dachigam nullah produced my only record.

Lanius shach Rufousbacked Shrike

Even though B & L say it begins to leave the Vale in September, I still found it numerous in all habitats; gardens, paddy fields or the lower thorny slopes, and also Dachigam nullah.

Pericrocotus brevirostris Shortbilled Minivet

B & L found it to be a bird of pines from 3000-10,000′ (900-3000 m), perhaps commonest at 6000′ up to 8000′ (1800-2400 m).

My only record of this species was a pair in Dachigam nullah in deciduous trees. Like most of the flycatchers, the rest had probably already left for winter quarters.

Dicrurus leucophaeus Grey Drongo

B & L say it occurred in and around the Vale but was not particularly numerous.

It either leaves for its winter quarters early or is even less common than it was, because I came across it only in Dachigam nullah.

Acrocephalus stentoreus Indian Great Reed Warbler

In B & L's day it occurred in very large numbers on the Dal Lake, amongst other places.

I saw only 4 birds during 2 or 3 hours on the Dal Lake and on a couple of occasions elsewhere in roadside reedbeds. The increased commercialisation of the Lake has obviously not been to its liking, even allowing for the fact that my visit was well towards the end of its breeding season.

Bradypterus major Largebilled Bush Warbler

Locally common between 8000 and 10,000′ (2400-3000 m), according to B & L.

I came across it only once, in bushes beside the nullah above Gulmarg.

Sylvia althaea Hume's Lesser Whitethroat

B & L found it common on barer hillsides up to 8000′ (2400 m).

I found it common on the thorny slopes above Pari Mahal and also in Dachigam.

I found it impossible to see any difference, even in habits and habitat from the allegedly different species of Britain and Europe, *S. curruca*, and would be inclined to follow Williamson (1964) in considering them one species.

Phylloscopus affinis Tickell's Leaf Warbler

Distributed generally above the tree line from 10,500′ to 15,000′ (3150-4500 m), according to B & L.

I found several birds in the birch scrub on the slopes of Aphawat above Killenmarg, but could not be certain that any had dropped down to join the mixed flocks of warblers, tits etc. around Gulmarg. (I am always thankful that I took with me Williamson's work (1962) on the identification of phylloscopi. The task of separating the species would have been impossible without it. Even then it was difficult enough and many individuals went unidentified).

Phylloscopus tytleri Tytler's Leaf Warbler

B & L say it was found throughout the pine and fir woods but was not particularly common.

I came across singularly nondescript leaf warblers assumed to be this species occasionally around Gulmarg and also in Dachigam nullah. In the latter locality the birds must have come down from the pine woods on the steep slopes above. (Both Plain Leaf Warbler *P. neglectus* and Mountain Chiffchaff *P.* (*collybita*) *sindianus* are possible but much less likely, though the latter could be migrating through Dachigam at that time of year).

Phylloscopus proregulus Pallas's Leaf Warbler

Ticehurst's Willow Warbler (B & L called all phylloscopi 'willow-warblers'). According to B & L, fairly common from 7000–10,000′ (2100–3000 m) in fir woods.

I found this species around Gulmarg, more particularly along the nullah up to Killenmarg.

Phylloscopus inornatus Yellowbrowed Warbler

A common bird, particularly in silver firs from 7500′ (2250 m) to the tree limit, according to B & L.

I certainly found it common in and above Gulmarg, and along with *P. occipitalis* was the most numerous of warblers in the mixed hunting parties.

Phylloscopus magnirostris Largebilled Leaf Warbler

B & L found it widely distributed between 7000 and 10,000′ (2100–3000 m) generally along banks of streams through forests.

I encountered this bird twice; once in Dachigam nullah (where it was recorded by Ward) and once at Gulmarg in a large mixed flock.

Phylloscopus occipitalis Large Crowned Leaf Warbler

B & L say it was surprisingly common in all types of forest, most numerous between 6000 and 8000′ (1800–2400 m).

Despite the fact that they go on to say that its dispersal begins in July and it leaves by September, I found it quite common around Gulmarg (see Yellowbrowed Warbler). It must have been less numerous and widespread than B & L indicated, so numbers must have already left.

Cettia fortipes Strongfooted Bush Warbler

Homochlamys pallidus Pale Bush Warbler.

B & L found it from 3000–8000′ (900–2400 m) on the slopes around the side of the Vale and up the side valleys.

I came across it in the undergrowth in Dachigam and also in the undergrowth of a pine wood near the top of the slope above Pari Mahal.

Regulus regulus Goldcrest

B & L imply that this species was rare and only found in small numbers and Osmaston is quoted as seeing it at Gulmarg.

I found almost every hunting party of small insectivorous birds around Gulmarg contained a pair or two of this species. It appears to have increased, at least locally, at Gulmarg. (In Europe it is known to suffer badly in particularly hard winters and an investigation of the weather regime may be a useful enquiry).

Oriolus oriolus Golden Oriole

Common in the Vale, especially groves and orchards, from B & L.

My visit was almost at the end of their stay (they are quoted as leaving by 20th Sept.) but I found two in Orchards near the hotel and in Dachigam nullah.

Sturnus vulgaris Starling

According to B & L, a common summer visitor to the Vale which leaves in August and September.

I found this species only in and around Srinagar and noted it was vastly outnumbered by the Common Myna. Unless the Starling is very much more numerous at the height of the season it must have lost ground.

Acridotheres tristis Common Myna

B & L say it was common in the Vale.

I found it very common in and around Srinagar. Both it and the Starling are parasites of man and compete for nest sites and the former has the advantage of being resident. It has probably gained at the expense of the Starling.

Mycerobas icteroides Black and Yellow Grosbeak

Perrisospiza icteroides

Evenly distributed from 6000–10,000′ (1800–3000 m) with vertical movement in winter, according to B & L.

A flock of about 15 near Babarishi and a single bird at the head of gorge where the nullah leaves Gulmarg meadow were my only records. The forests above Gulmarg were not to its liking apparently, unless the downward winter movement had already begun.

Carpodacus rhodochrus Pinkbrowed Rosefinch

Propasser rhodochrus

B & L imply that it was the most widespread of the three species of rosefinch which breed in Kashmir and it was generally distributed between 9000 and 12,000′ (2700–3600 m).

A party of 5 rosefinches with completely pink underparts which flew over the birch woods above Killenmarg must have been this species.

Carpodacus erythrinus Common Rosefinch

Hodgson's Rosefinch

B & L say it was not uncommon above 8500′ or 9000′ (2550 or 2700 m) but could trace no records for the Pir Panjal mountains.

I am pleased to report there now is one. A single male rosefinch in a large mixed party near the garden of my chalet at Gulmarg was viewed well and closely and I could find no reason for identifying it as anything other than this species. One seen less well in the scrub at Killenmarg could not be positively identified. I also came across a small party in the Sind river and a few in Dachigam nullah.

Carduelis carduelis Goldfinch

C. caniceps

Obviously a common bird in B & L's day from the Vale to 11,000′ (3300 m) and the situation has not changed since, because I found it in gardens near the Dal Lake, up the Sind river, the steep slopes near Babarishi and at Gulmarg.

Callacanthis burtoni Redbrowed Finch

B & L say it was a bird of fir forests from 7500 to 10,000′ (2250–3000 m) and gave Gulmarg as one of its strongholds.

It was thus surprising that I only saw it once at Gulmarg a solitary bird at that, in a mixed flock. It must have decreased.

Carduelis spinoides Himalayan Greenfinch

Hypacanthis spinoides

Very local according to B & L who gave the Sind valley and Gulmarg as two favoured localities, where I found it in both places.

Passer domesticus House Sparrow

I can add little to B & L's 'Excessively numerous in the towns and villages of the Vale'. With increasing urbanisation of Srinagar it has no doubt become more numerous still.

Passer rutilans Cinnamon Tree Sparrow

B & L say it was found all round the Vale from 6000-9000′ (1800-2700 m) and was numerous at Gulmarg.

I certainly found it common at Gulmarg with a flock of 50 on occasion, but not elsewhere.

Leucosticte nemoricola Hodgson's Mountain Finch

Fringilauda nemoricola Stoliczka's Mountain Finch

Abnormally common above the tree line from 11,000′ (3300 m) to almost 14,000′ (4200 m), according to B & L.

This must be a relative term because bird life generally is few and far between on high, bare mountains. However, I came across a flock of 50-60 drinking and bathing in a small stream at nearly 13,000′ (3900 m) on Aphawat.

Emberiza fucata Greyheaded Bunting

Not common but well dispersed round the rim of the Vale, and the Takht was quoted as a habitat by B & L. They also said it was scarce and found only up to 7000′ (2100 m).

I found this bird on the lower slopes around the Pari Mahal in association with Rock Buntings, and also in Dachigam nullah near the former hunting lodge. I did not identify either this or the next species for certain on the Takht. It is possible the making of the new road may have caused too much disturbance.

There is something peculiar about what is alleged to be the colour illustration of this species on plate III in B & L. It has little resemblance to the description in the text but is a good likeness of Cretzmar's Bunting *E. caesia* or could even pass as an Ortolan Bunting *E. hortulana* but certainly not the species it is supposed to be.

Emberiza stewarti Whitecapped Bunting

B & L say it was common around the rim of the Vale but was found only up to 6000′ (1800 m), and was also found on the Takht.

Apart from adult males, the species is not readily distinguished from the previous one and may have been overlooked. I saw it only once; a small party (family group ?) on the lawn of the lodge in Dachigam. The grassy, boulder strewn hillside above appeared to be an ideal habitat.

Emberiza cia Rock Bunting

Meadow Bunting

Numerous and widespread, according to B & L, from 6000′ to 10,000′ (1800-3000 m)

I found it all the way up the slope from the Pari Mahal upwards. It was most numerous in the open pine clumps around 7000′ (2100 m). A bunting seen too briefly to identify at Gulmarg was probably this species.

Delichon urbica House Martin

The status of this bird appears to be a few high altitude colonies between 9000 and 12,000′ (2700-3600 m), if B & L are interpreted correctly.

There were several flying about the precipitous cliff face which towers over the road at the narrowest part of the Sind river gorge on the way to Sonamarg. This looked a suitable nest site but is well below B & L's lower limit. It would be worth investigating in the breeding season. I also found some in a large mixed flock of hirundines apparently migrating down Dachigam nullah.

Hirundo rustica Swallow

Obviously a very common bird in the Vale from what B & L say about it.

I found this bird commonest in flocks around the barer hills such as the Takht and the summit above Pari Mahal. There was also a large number apparently migrating down Dachigam nullah.

Motacilla alba Pied Wagtail

Very numerous in the main Vale, according to B & L and ascending the side valleys to 10,000′ (3000 m).

Two birds on a shingle bank in the lower Sind river were the only ones away from the Vale, where it was a bird of lawns and gardens around the Dal Lakes. Less numerous than B & L found but the winter exodus could have already begun.

Motacilla caspica Grey Wagtail

M. cinerea

On all streams outside the Vale up to 13,000′ (3900 m), from B & L.

This was also my experience and I found it on most streams visited except the Sind river e.g. Dachigam nullah, the stream above and below Gulmarg and the mouth of the gorge below Babarishi.

Anthus pelopus Hodgson's Pipit

A. roseatus

B & L say this was the common pipit above the tree line and I therefore presume that a pair of pipits flying overhead at Killenmarg were this species. Tree Pipit *A. trivialis* was also possible in this habitat, but much less likely as B & L had no record of it for the Pir Panjal mountains.

Alauda gulgula Eastern Skylark Negative

I never consciously saw this bird which was very common and widespread according to B & L. Admittedly I did not examine any typical habitat and it would be very inconspicuous outside the breeding season.

Zosterops palpebrosa White-eye

B & L imply that it was irregular and uncommon but I found a small number in Dachigam nullah.

Picus squamatus Scalybellied Green Woodpecker

B & L say it was found from 4500′ to 10,000′ (1350-3000 m) but was not particularly common.

I saw only one, just below Killenmarg which is right at the top of its range

Dendrocopus himalayensis Himalayan Pied Woodpecker

Dryobates himalayensis

Widely distributed from 6500′ to 10,000′ (1950-3000 m), from B&L.

I agree with B&L that it is the commonest of Kashmir's woodpeckers and I saw two in Dachigam and it was quite common at Gulmarg, often climbing up the walls of the wooden houses.

Dendrocopus auriceps Brownfronted Pied Woodpecker

Dryobates brunifrons

Not very common and found only in the Vale, according to B & L.

The only one I saw flew over the hotel lawn while I was having breakfast.

Psittacula himalayana Slatyheaded Parakeet

B & L say it was almost entirely confined to the Deodar forests to the north of the Wular Lake in the breeding season, but raided orchards later in the year.

From the above, it was one of the major surprises of the trip to find a flock of 9 or 10 mostly immatures, feeding on fruit in the Mogul gardens. On another occasion, a flock was seen flying westward across the Dal Lake in the evening. There is no mention in B&L of the birds having been recorded in Srinagar and these observations appear to indicate a new development.

Coracius garrulus European Roller

B & L found its stronghold to be the main Vale with a penetration of the larger side valleys and quote Meinertzhagen who found only a few left round Srinagar in September.

I did not find any in the immediate environs of Srinagar but it was thinly distributed in the northern part of the Vale towards the Wular Lake and up the lower Sind valley. Apart from these there was a single bird on the hillside near Babarishi.

Merops apiaster European Bee-eater

'Confined to the main Vale and the lowest reaches of the side valleys . . . leaving in September' B & L.

In behaviour and occurrence it was markedly similar to the Swallow. Flocks were flying round the Takht, the summit of the slope above Pari Mahal and in Dachigam nullah.

Alcedo athis Common Kingfisher

B & L's statement that it was exceedingly common in the Vale is equally true today.

Its numbers around Srinagar and the Dal Lake have to be seen to be believed, whether in murky backwaters or along the parapet of the main road along the south and SW shore where there was a bird every 20 or 30 m. Some birds still seemed to be nesting high on the Takht.

Oddly enough I had no definite record of the Pied Kingfisher *Ceryle rudis* which B & L say was also common. However, it appears to prefer quieter waters which I did not investigate.

Apus melba Alpine Swift

The status of this species is not very clear from B & L but it appeared to be spasmodic and local.

I saw flocks in the upper Sind valley at the mouth of Nichnai nullah just short of Sonamarg, over Killenmarg and near Babarishi.

Apus apus Swift

Micropus apus Eastern Swift

'Numerous and widespread . . . usually high up the more precipitous and rocky mountain sides' B & L.

A group with Alpine Swifts over Killenmarg was my only record.

Gyps himalayensis Himalayan Griffon Vulture

B & L say it was common from the lowest to the highest elevations but absent from the Vale.

I saw it regularly at Gulmarg and there was a pair circling round a high crag above Dachigam (see Chough) and a single bird near Babarishi. The highest of these was at Killenmarg, 11,000′ (3300 m)

Neophron percnopterus Egyptian Vulture

Large White Scavenger Vulture

B & L say it was widespread but not common and that it occurred on the Takht.

I saw 2 regularly round the Takht and 2 at the gorge below Babarishi.

Gypaetus barbatus Bearded Vulture

Widely distributed above the tree line according to B & L, but I only saw it once, gliding near the summit of Aphawat.

Falco subbuteo Hobby

B & L found it widespread in woodlands from the Vale to the tree line but I came across it only at Gulmarg where one was seen several times.

Falco tinnunculus Kestrel

B & L say it was widespread throughout the area and was commoner than the Hobby.

I saw it only near Sonamarg and at Gulmarg.

Hieraaetus pennatus Booted Eagle

B & L appear to be uncertain of its status but suggest it was not uncommon. The Takht and Sind valley are quoted as two localities.

I saw a bird over Nishat Bagh and probably the same one several times over the hotel, another near Sonamarg and two at the mouth of the gorge below Babarishi. From this it appears to be well distributed at lower elevations around the Vale and up the side valleys.

Haliaeetus leucoryphus Pallas's Fishing Eagle Negative

According to B & L it was a feature of the Vale and was almost common around Wular Lake.

I regret to say I never saw it and can only conclude that the increased disturbance has been too much for it and it occurs no longer, unless it holds on in some of the more secluded lakes.

Milvus migrans Black Kite

Blackeared Kite

I prefer the English name of the typical race to avoid the tiresome variations attributed to other races.

B & L found it common in the Vale and the lower reaches of the side valleys and say it wandered to higher levels without giving a limit.

It was exceedingly numerous in and around Srinagar and elsewhere in the Vale and a flock of 50-100 kept a close eye on the hotel rubbish dump. There were also some at Gulmarg, round the pony stand mainly.

Buteo rufinus Longlegged Buzzard

Not uncommon from the Vale to 13,000′ (3900 m) according to B & L.

I saw one near Wular Lake (a locality quoted by B & L) and 2 birds in a gulley on the lower slopes of Aphawat at about 11,000′ (3300 m). These could have been direct descendants of birds found nesting in a big fir ' above Gulmarg ' by Osmaston.

Columba livia Blue Rock Pigeon

B & L say it was not uncommon in the Vale but preferring the side valleys and gorges.

As anywhere else, feral pigeons abound in Kashmir and the only apparently genuine wild birds were two in the gorge below Babarishi.

Streptopelia orientalis Rufous Turtle Dove

The status given it by B & L remains valid today. It is *the* dove of all fir woods outside the Vale and was very common around Gulmarg up to the limit of the fir woods, approx. 10,000′ (3000 m).

Streptopelia decaocto Collared Turtle Dove

Ring Dove

This dove remains the common bird of gardens and open country around Srinagar as it was in B & L's day.

Alectoris chukar Chukor

Particularly common on the barer rocky hillsides around the northern and western rims of the main Vale, according to B & L.

I flushed a covey from the ruins of Pari Mahal and judging by the number of calls from the adjacent hillsides it was common all round.

Tetraogallus himalayensis Himalayan Snow Cock

B & L say it occurred on the Pir Panjal and quote Osmaston as finding it above Gulmarg, at 12,000′ (3600 m).

I found a single bird at about 13,000′ (3900 m) on Aphawat. It was in very broken ground and there could have been more out of sight.

Gallinula chlorops Moorhen

Common on marshes in the Vale according to B & L.

A pair with young in the backwaters of the Dal Lake was my only record. It presumably survives in greater numbers on the more secluded lakes.

Hydrophasianus chirurgus Pheasant-tailed Jacana Negative

B & L say it was common on the marshes of the Vale and that it could not be missed during a trip on the Dal Lakes.

This is another species which must have succumbed to increased human population and disturbance because I never saw it.

Chlidonias hybrida Whiskered Tern

Even in B & L's day it was greatly reduced on the Dal Lake due to human predation and disturbance, but had retired to more secluded waters.

I found a small party of 5 or 6 hunting regularly over the Dal Lake and about 15 over Wular Lake. This was rather late in their season because Meinertzhagen found that they all left by 21st Sept.

Vanellus indicus Redwattled Lapwing

Lobivanellus indicus

B & L say it occurred in the Vale but was commonest on islands in the lower reaches of the side rivers.

It was in just such a locality in the Sind river that I saw my only 2 birds.

Ardea cinerea Grey Heron

Widely spread and comparatively common in the Vale, according to B & L.

Only two sightings, one near Sopor, Wular Lake and the other over Srinagar itself of such a large and conspicuous bird can only indicate a severe decline in numbers.

Nycticorax nycticorax Night Heron

Fairly plentiful round the larger jheels from the vicinity of Srinagar to Wular Lake, according to B & L.

Two flying over Srinagar one evening was my only record, but this crepuscular bird could be overlooked. It does not appear to object to disturbance because it has become quite urbanised in the Alipore area of Calcutta, and could still be maintaining its numbers.

Ixobrychus minutus Little Bittern

B & L imply that it was common in all reed beds in the Vale, even on the Dal Lake.

About four seen in 2 hours in the reedy backwaters of the Dal Lake, and on other occasions at marshy edges, indicates it was still present but less common than it was.

Aythya nyroca White-eyed Pochard

Aythya rufa

Distributed in some numbers on all the jheels which have some cover, according to B & L.

A single bird on Manasbal lake was the only record of this, or any other, duck.

Podiceps ruficollis Little Grebe

Very common on all the lakes and marshes of the Vale, from B & L

The most frequently seen water bird on the Dal Lake, but even then, only 6 was far from numerous. This must indicate a considerable decline in numbers at this place at least.

SUPPLEMENT

B & L included a number of species in a supplement for which they had no records themselves or no definite breeding records for the area. Birds on this list which were seen by me are :—

Certhia familiaris Tree Creeper

Hodgson's Tree Creeper

B & L did not appear to have much first hand experience of this species and had difficulty separating it from the Himalayan Tree Creeper. Osmaston and Ward found it at Gulmarg.

This species was identified for certain several times at Gulmarg being satisfactorily separated from Himalayan Tree Creeper although a number of *Certhia* sp. remained indeterminate. It may be locally common at Gulmarg, or on the Pir Panjal generally.

Seicercus xanthoschistos Greyheaded Flycatcher-Warbler

Osmaston is quoted as saying it doubtless breeds in Dachigam Nullah. The only bird I saw was in this locality.

Prinia criniger Brown Hill Warbler

Suya criniger

This identification is somewhat doubtful because the bird did not have the characteristic long tail of this species. However it is possible the bird was in moult at this time of year. Apart from this, the size, field characters, behaviour and habitat all match that of Brown Hill Warbler. Other possibilities are even less likely.

A small brown nondescript bird heavily streaked with black above but devoid of other features was watched at very close quarters for a couple of minutes as it crept about on the ground amongst the stems of tall growing weeds in a patch on the edge of a fir forest near Sonamarg.

B & L found this species up to 5400′ (1620 m) in the Kishenganga valley and up the Jhelum road, so this would be 3000′ (900 m) higher than its haunts elsewhere but Sálim Ali (1949) gives it up to 7000′ (2100 m).

There is a small possibility it was a species of accentor *Prunella* sp. but it did not have the conspicuous supercillium of *strophiata* and it was not *colluris*. B & L give no records of any other species in Kashmir, but Ripley (1961) indicates that the Altai Accentor *P. himalayana* could occur and also the Brown Accentor *P. fulvescens* and Blackthroated Accentor *P. atrogularis* in winter.

Riparia rupestris Crag Martin

Two with other hirundines in Dachigam nullah, probably on passage.

Aegypius monachus Cinereous Vulture

A very dark vulture with the characteristic wedge-shaped tail of this species sailed low overhead at Gulmarg.

In the above list, negative records have been given only for those species which, firstly, were found by B & L to be so common as very unlikely to be missed, and secondly those species for which a particular search was made in a quoted area or habitat. Species which B & L found to be rare or local and which I was unlikely to come across have not been mentioned.

DISCUSSIONS AND CONCLUSIONS

The small number of localities which could be visited, even briefly, in the short time available obviously means it is impossible to give a precise picture of the present status of every species recorded by B & L. Furthermore, much of the northern part of the area covered by them is now inaccessible across the cease-fire line. Ornithologically, the picture is further confused by the departure of summer visitors. Nevertheless, there is strong evidence that a number of wetland species have greatly declined or even disappeared altogether. Unfortunately I did not have the opportunity to visit any of the protected waters such as Hokra Jeel where the situation ought to be better. Other observers may wish to check this. More by inference than evidence, the common urban species of much of lowland India have probably increased around Srinagar. Most old records for the Gulmarg area are confirmed, except for the absence of Variegated Laughing Thrush, and one has been added ; Common Rosefinch. Cinereous Vulture may also be new.

A small passerine of doubtful identity near Sonamarg offers some intriguing possibilities.

Kashmir with its large area and relatively small population has only one wild life sanctuary at present in Upper and Lower Dachigam and in view of the drastic reduction in the more spectacular high altitude fauna found by the World Wildlife Fund in West Pakistan, there is scope for more. (Could the absence of a record of any species of pheasant be due to excessive hunting ?) From the point of view of avifauna and for accessibility for people to observe it, Gulmarg area has much to recommend it.

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Observations on the behaviour of clams in waters of low salinity

BY

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AND

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(*With seven text-figures*)

Of the several species of venerid clams that occur on the coast of Maharashtra State, *Meretrix meretrix* L. and *Katelysia opima* Gml. contribute nearly 70 per cent of the total catch of clams landed annually. They are found in most of the estuaries and backwaters of the coastal belt of the state. The clams being found mostly in the estuarine environment, are naturally subjected to fluctuating ecological conditions which exert great influence on their life. During ebb tide, specially during spring low tide, the clam beds get exposed to air, resulting in desiccation of animals. There are great fluctuations in salinity owing to tidal oscillations and river discharge. During monsoon, the salinity of the water over the clam beds may remain low for a long period. The clams in such areas, therefore, have to adapt themselves to overcome these changes. Survival and behaviour of clams in low salinities have been studied by many workers in case of the temperate species. Most of these studies have been made on the edible oysters by Amemiya (1928), Hopkins (1936), Ingle & Dawson (1950) and Loosanoff (1948, 1950, 1952), Chalney (1958) has studied survival of juvenile bivalves in waters of low salinities and Motwani (1956) studied adaptations in *Mytilus edulis* to salinity fluctuations. No work appears to have been done on the survival and behaviour of bivalves from Indian waters, in waters of low salinity, though this aspect is considered important from the management point of view, especially if culture operations are to be undertaken. The present investigation was, therefore, undertaken to study the survival and behaviour of clams, *Meretrix meretrix* and *Katelysia opima* in waters of low salinities.

While studying the biology of these clams, it was found that the salinity of the water in the Kalbadevi estuary, from where the clams were collected, varied from 4‰ to 35.8‰ during the year. The lowest salinity was observed in the months of July and August on account of rain and flooding of the river. However, no large scale mortality of clams was observed. It was, therefore, natural to assume that these clams could tolerate wide fluctuations in the salinity. Some of the clams brought from the beds, when the salinity was high (34·0 ‰), on transfer to pure fresh water, were found to close their valves immediately, remaining in this condition for even two days ; but when re-transferred to sea water, they opened their valves within a short time. The closure of the shell valves becomes an adaptation to withstand unfavourable conditions in the environment, thereby keeping the mantle fluid unaffected by external changes. This adaptation is only a temporary measure, so long the animal is able to live without opening the valves for both respiration and feeding. Besides, it has also been observed that the salinity has great influence on the growth and breeding of these clams.

The purpose of the present work was, therefore, to investigate how far these clams are adapted to the environment so far as the changes in the salinity were concerned. This was done by conducting a series of experiments in the laboratory to determine the following objectives :

(1) The low salinity tolerance range.

(2) Time taken in opening of the valves in relation to salinity.

(3) Efficiency of the valve-closing mechanism.

(4) The nature of stimulus which controls opening and closing of valves.

MATERIAL AND METHODS

Live specimens of both species were brought from the Kalbadevi estuary, washed and kept in sea water in large trays in the laboratory. The sea water in these trays was changed every day. A period of 48 hours was found to be sufficient for the clams to be conditioned and for throwing adequate extraneous matter. From November to March the period during which these experiments were conducted, the salinity of the sea water over the clam bed varies between 30 ‰ and 34 ‰, whereas that of the sea water brought to the laboratory varied between 33 ‰ and 35 ‰. Various dilutions of sea water in the laboratory were made by adding distilled water. No food was given to the clams while under storage and experimental conditions. During ten days' observations of the salinity tolerance experiments, sea water of requisite concentration was replaced every 48 hours. Salinity of the sea water was determined by titration with silver nitrate, using potassium chromate as an indicator.

RESULTS

(1) *Low salinity-tolerance range*

Experiments were conducted in enamel trays, each of which was filled with two litres of sea water of varying dilutions as required. In all the experiments, only one size range of clams was selected; for *M. meretrix* 35 mm to 40 mm and for *K. opima* and 25 mm to 30 mm as these sizes were common in the commercial catches landed at Ratnagiri. Water in which the clams were subjected for tolerance studies ranged from fresh water to 100 per cent sea water (salinity 35‰), with intermediate percentage namely 5, 10, 20, 30, 40, 50, 60, 70, 80 and 90. In each tray, 20 clams were subjected for a period of ten days. The dilutions, wherein the survival was 50 per cent and above at the end of this period, were regarded as a ' tolerating ' range. The clam was considered as dead, if it did not close or react when touched with a glass rod.

The results of the experiment on *K. opima* are given in Table I and are shown graphically in Fig. 1.

TABLE I

PERCENTAGE MORTALITY OF *K. opima* IN VARIOUS CONCENTRATIONS

No. of days	Percentage of sea water											
	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.	—	—	—	—	—	—	—	—	—	—	—	—
2.	30	25	25	10	5	—	—	—	—	—	—	—
3.	50	40	35	20	5	—	—	—	—	—	—	—
4.	15	15	20	45	20	—	—	—	—	—	—	—
5.	5	20	20	25	50	5	—	—	—	—	—	—
6.	—	—	—	—	20	10	5	—	—	—	—	—
7.	—	—	—	—	—	10	—	—	—	—	—	—
8.	—	—	—	—	—	5	5	5	—	—	—	—
9.	—	—	—	—	—	—	—	—	—	—	—	—
10.	—	—	—	—	—	10	10	5	—	—	—	—
	100%	100%	100%	100%	100%	40%	20%	10%	0%	0%	0%	0%

From the graph, it would be seen that in dilution from 0% to 30% sea water, there was 100% mortality within six days of the commencement of the experiment. In 40% sea water, it was observed that only 15% mortality took place at the end of six days, and 40% at the end of ten days. The curve for 40% sea water considerably deviates from those of the lower grades indicating that the tolerance-range has been approached and that the clams can tolerate this salinity as adjudged by 50% survival at the end of ten days period. In 50% sea water there was only 5% mortality in six days and 20% mortality in ten days. The curve for 50% sea water shows still further deviation. In 60% sea water there was no mortality at the end of six days and only 10% mortality at the end of ten days, whereas in sea water of 70% and above there was no mortality at the end of ten days. From this, it can be inferred that *K. opima* could tolerate low salinity as much as 40% sea water or salinity of 14·0‰ under laboratory conditions when the transfer to low salinities is sudden.

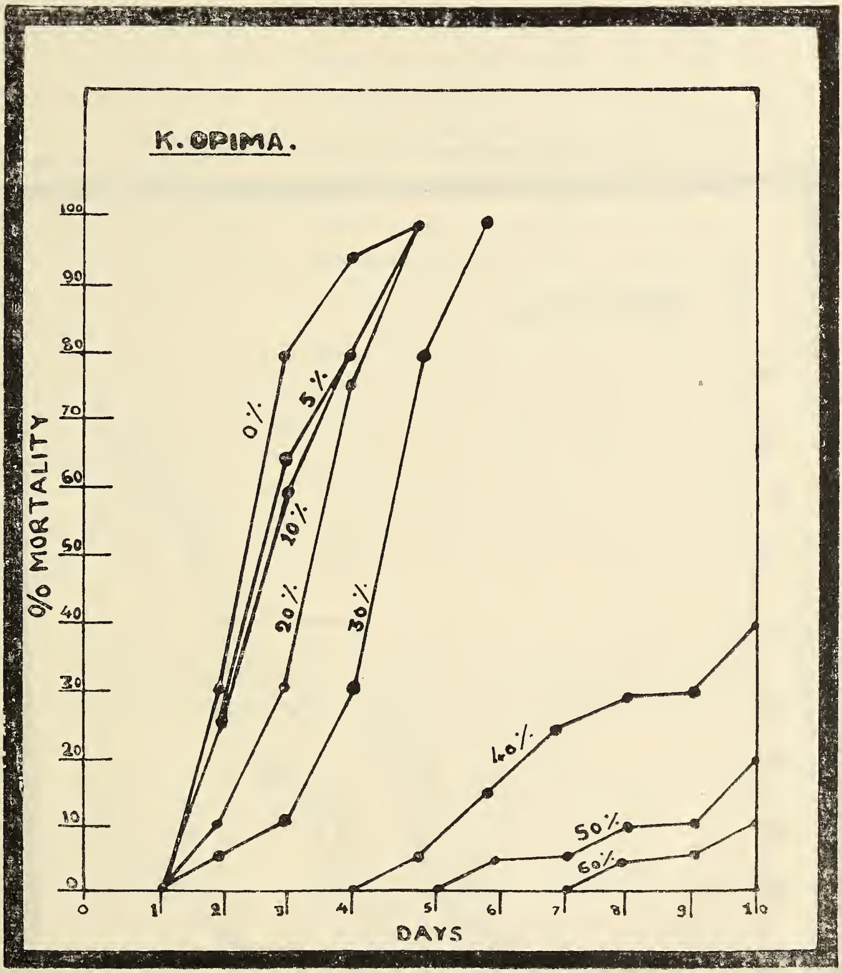

FIG. 1.

The results of the experiments conducted on *M. meretrix* are given in Table II and are shown graphically in Fig. 2.

TABLE II

PERCENTAGE MORTALITY OF *M. meretrix* IN VARIOUS CONCENTRATIONS

No. of days	Percentage of sea water											
	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.	—	—	—	—	—	—	—	—	—	—	—	—
2.	—	—	—	—	—	—	—	—	—	—	—	—
3.	5	—	—	—	—	—	—	—	—	—	—	—
4.	10	10	5	—	—	—	—	—	—	—	—	—
5.	25	15	5	5	—	—	—	—	—	—	—	—
6.	25	30	10	10	10	—	—	—	—	—	—	—
7.	—	—	30	25	5	—	—	—	—	—	—	—
8.	5	10	10	10	—	—	—	—	—	—	—	—
9.	15	25	30	15	5	5	—	—	—	—	—	—
10.	15	10	10	35	10	5	—	—	—	—	—	—
	100%	100%	100%	100%	30%	10%						

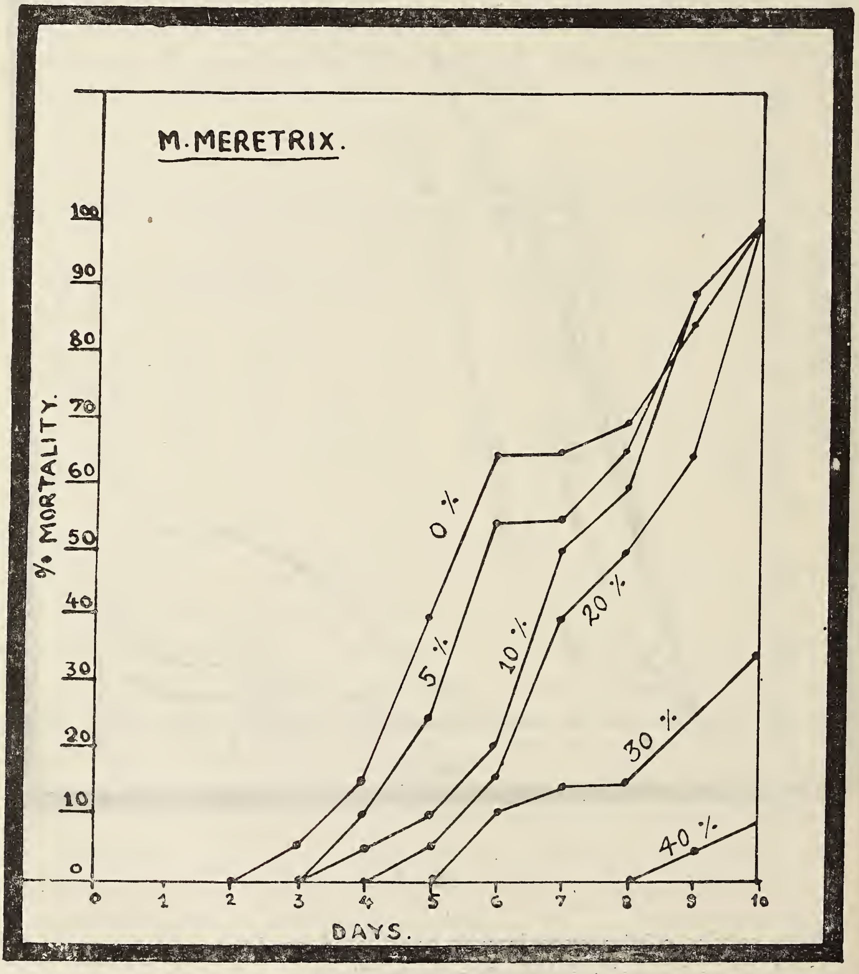

FIG 2.

From the graph, it would be seen that in dilutions from 0-20% sea water, there was 100% mortality in ten days. However, in 30% sea water at the end of ten days the mortality was only 30% indicating that this dilution was better tolerated by clams. The curve for 30% sea water also deviates considerably from the curves of 0% to 20% indicating that 30% is within tolerance range for the species as adjudged by 50% survival at the end of ten days. There is no mortality till eighth day in 40% sea water and the total mortality in ten days was only 10%. In percentages higher than 40% sea water there was no mortality at the end of ten days.

From this it can be concluded that *M. meretrix* is more tolerant to low salinities than *K. opima* and that it can withstand low salinity as much as 30% sea water (salinity 10.5‰) under laboratory conditions when the change to low salinities is effected suddenly.

The experiments on salinity-tolerance studies were conducted during the period November to March, when the salinity of the sea water at the clam beds varied only between 30‰ and 34%. It has been observed that this salinity is greatly reduced during the rainy season and at times reaches as low as 1.4‰ or nearly almost fresh-water. The average salinity during July and August varies between 4‰ to 12‰. The lethal limits of 14‰ and 10.5‰ for *K. opima* and *M. meretrix*, respectively, based on 50% survival arrived at by laboratory experiments would therefore, indicate that no clam would ever survive during the rainy season when the average salinity at the sea beds is much lower than the lethal limits. Since no mass mortality of clams has been observed in these beds, it would be logical to assume that the clams get acclimated

TABLE III

PERCENTAGE MORTALITY OF *K. opima* IN VARIOUS CONCENTRATIONS

No. of days	Percentage of sea water 0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.	—	—	—	—	—	—	—	—	—	—	—	—
2.	—	—	—	—	—	—	—	—	—	—	—	—
3.	—	—	—	—	—	—	—	—	—	—	—	—
4.	10	—	—	—	—	—	—	—	—	—	—	—
5.	30	25	20	10	—	—	—	—	—	—	—	—
6.	20	50	40	25	5	—	—	—	—	—	—	—
7.	15	20	25	15	5	—	—	—	—	—	—	—
8.	25	5	15	10	10	5	—	—	—	—	—	—
9.	10	—	—	5	15	5	—	—	—	—	—	—
10.	—	—	—	5	5	10	—	—	—	—	—	—
	100%	100%	100%	70%	40%	20%	0%	0%	0%	0%	0%	0%

to lower salinity in the gradual phase of dilution, caused by rain water during monsoon.

In order to study the effects of acclimatization to lower salinity on the survival value in clams, similar salinity tolerance experiments were conducted in the months of July and August. The sea water used in these experiments was of salinity 25·0‰ and this was taken as 100 per cent sea water. The results of these experiments are given in Tables III and IV and also represented in figures 3 and 4.

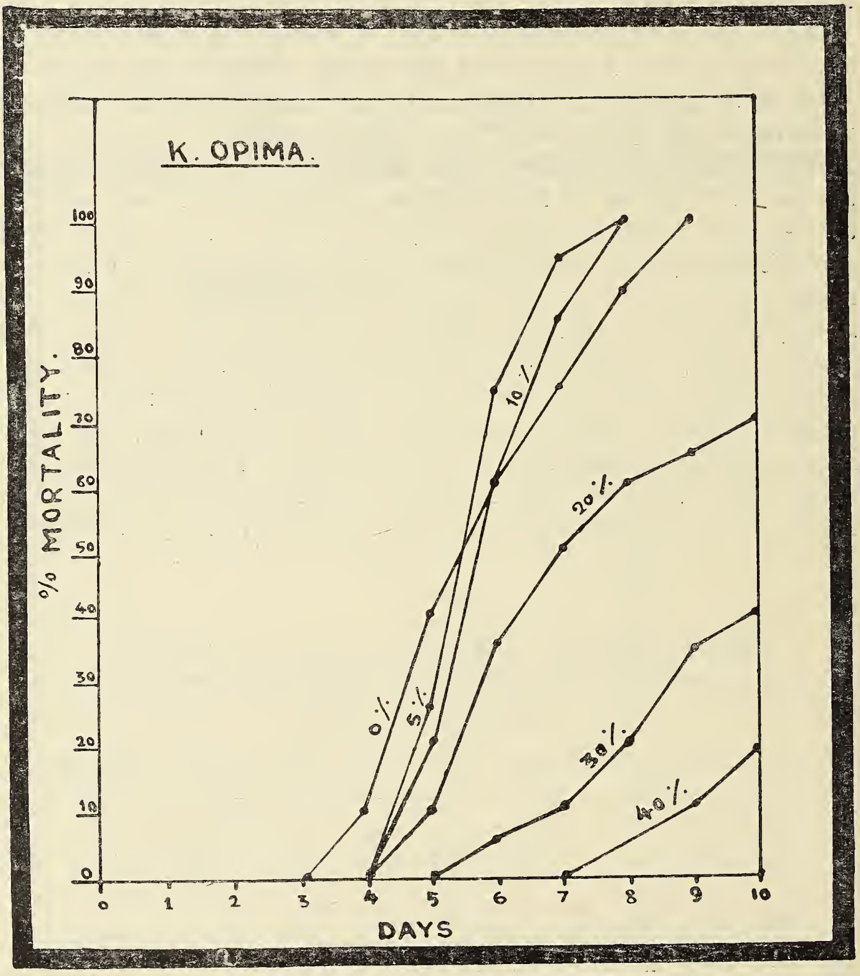

FIG. 3.

From Table III it could be seen that the lower lethal limit for *K. opima* works out to be 30% sea water or 7·5‰ based on 50% survival. This is much lower than the lethal limit found in the previous

TABLE IV

PERCENTAGE MORTALITY OF *M. meretrix* IN VARIOUS CONCENTRATIONS

No. of days	0%	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
1.	—	—	—	—	—	—	—	—	—	—	—	—
2.	—	—	—	—	—	—	—	—	—	—	—	—
3.	—	—	—	—	—	—	—	—	—	—	—	—
4.	—	—	—	—	—	—	—	—	—	—	—	—
5.	10	—	—	—	—	—	—	—	—	—	—	—
6.	30	20	10	—	—	—	—	—	—	—	—	—
7.	10	20	20	5	—	—	—	—	—	—	—	—
8.	30	35	15	10	—	—	—	—	—	—	—	—
9.	10	10	10	5	10	—	—	—	—	—	—	—
10.	10	15	25	10	5	—	—	—	—	—	—	—
	100%	100%	80%	30%	15%	0%	0%	0%	0%	0%	0%	0%

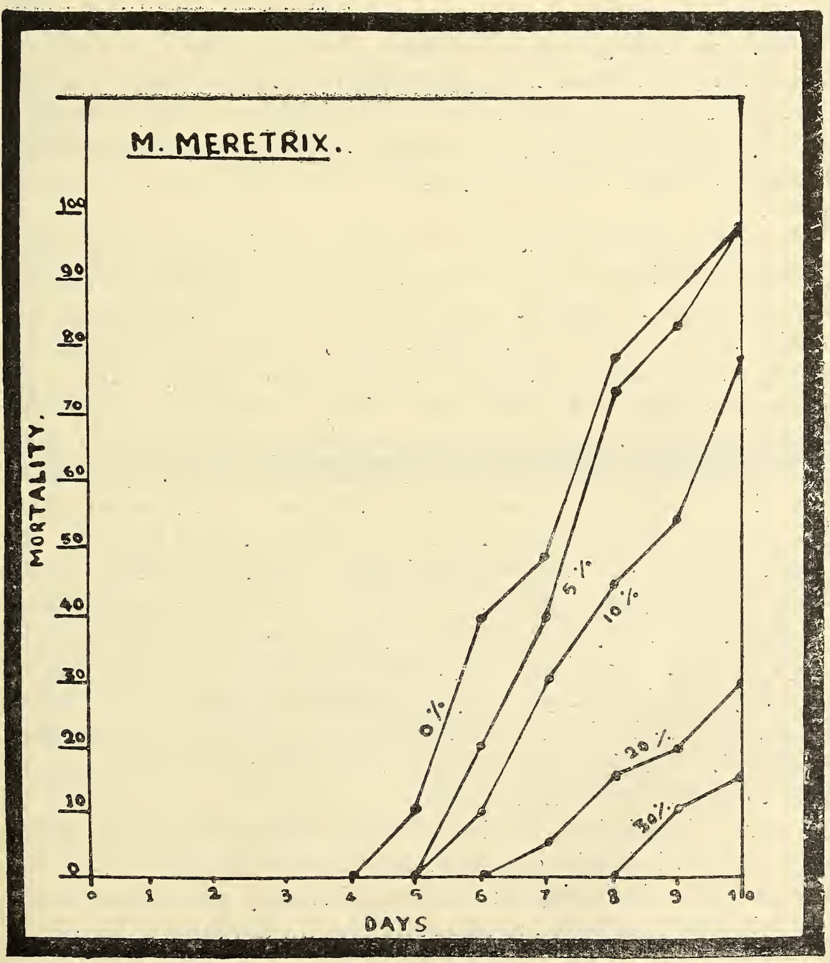

FIG. 4.

experiment viz. 14·0%. Similarly in case of *M. meretrix* (Table IV) the lower lethal limit is reduced to a level of 20% sea water or 5·0‰ as against 10·5‰. This indicates that the continual submergence during the monsoon enables clams to re-act by acclimatization to low salinities and the lethal limits are further reduced to such a level as not to have any harmful effect on the animal. Acclimatization probably helps the clams survive the drastic conditions met with during rainy season.

(2) *Time taken in opening of the valves in relation to salinity :*

While studying the salinity tolerance, it was observed that the clams did not open their valves in low salinities whereas they did so immediately in higher salinities. The relation between the time taken in opening of the valves and the salinity of the external medium was therefore studied in detail. About ten specimens were used in each of the various grades of sea water dilutions and the time taken for opening of the valves was noted.

While conducting these experiments, it was observed that there was some individual variation in the behaviour of clams in different salinities. Some clams took as much as five minutes to open in 100% sea water and only one minute in 70% sea water. Apart from such deviations in certain individuals, the general pattern of behaviour was more or less similar.

For comparison, the mean values of the time taken by ten individuals in different dilutions of sea water are represented graphically in figure 5. From the graph it could be seen that the curves for *M. meretrix* and *K. opima* show more or less a similar trend, though the time taken for opening of the valves in both the species varied slightly. There is a progressively increasing delay in time taken for the valves to open with increase in dilution. In *M. meretrix*, the time taken to open in 100% to 40% sea water was about three minutes, though there was a progressive delay with reduction in the salinity. In 30% sea water however, about eight minutes were required, more than twice the time taken for the valves to open in 40% sea water and above, indicating that the critical salinity was being approached. In 20% sea water the clams behaved very much differently, opening after 1½ to 2 hours for a short time and then closing the valves indefinitely. Thus clams can be said to tolerate nearly 30% dilution and probably the indefinite closing of the valves in 20% sea water and below indicated that salinity of lethal range had been approached. The closure of valves in such cases would be reaction to adjust to unfavourable environment.

A more or less similar behaviour was observed in the case of *K. opima*, except that the indefinite closing of the valves took place in 30% sea water and below indicating that the critical salinity was reached in the range below 40% sea water, as also seen from the deviation of the curve.

Indefinite closing of the valves took place in 30% (10·5‰) and 20% (7·0‰) sea water in *K. opima* and *M. meretrix*, respectively. Changes in the salinity of sea water during summer and winter are not appreciable but in the rainy season especially in the months of July and August the fluctuations are very great. It was, therefore, considered necessary to study the behaviour of clams in opening and closing of the valves when they are subjected to great fluctuations in salinity as are met with in the rainy season. To determine the changes in the salinity in the monsoon that occur over the clam beds, observations were made for a period of 12 hours on 11th August 1961. The rise and fall in the salinity as observed are given below in Table V.

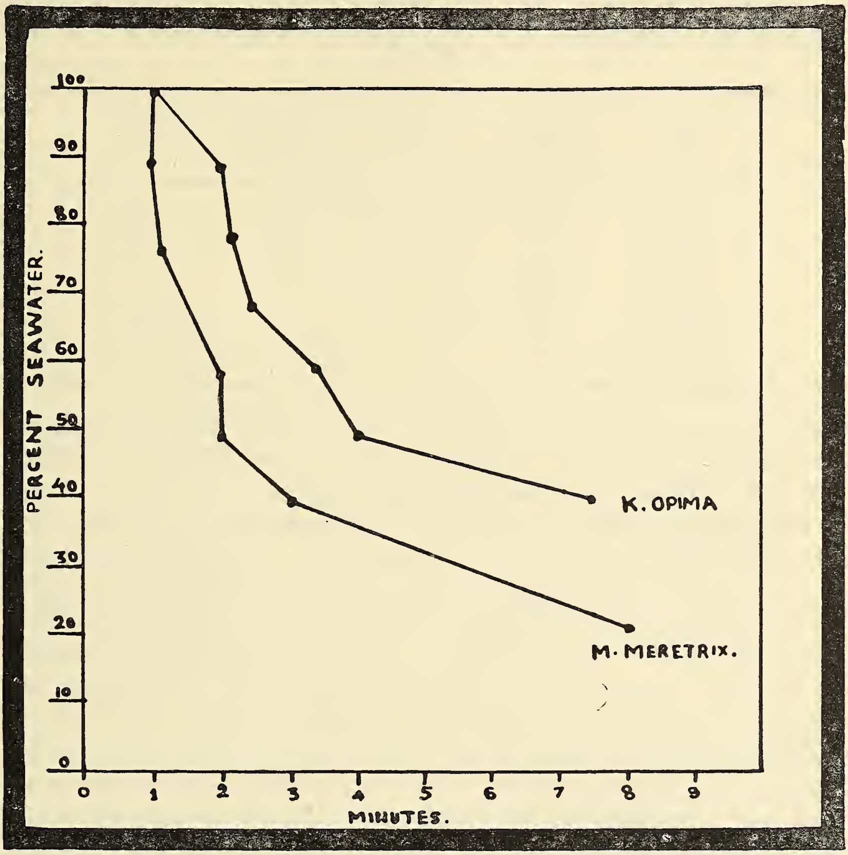

FIG. 5.

During the period of 12 hours, the salinity was observed to vary as much as between 1·4‰ to 22·9‰. The lowest salinity was recorded in the morning at 06.00 hours, when there was a low tide, the height of water being only 2.9 feet. Higher salinities were recorded at 10·00, 12·00 and 14·00 hrs. when there was a high tide with 13·8 feet rise. Then the tide started receding. However, in the evening the low tide (5.1 feet) was not as low as in the morning (2·9 feet) and accordingly, the fall in the salinity was also less (8·8‰). These observations indicate that the rise and fall in the salinity of sea water are very rapid, perhaps because of the tidal effect which is always prevalent in the estuary. The low tide in the morning was at 05·34 hrs. So the incoming tide would start bringing fresh sea water at about 08·30 hrs. The salinity at 08·00 hrs. was still low (1·4‰). Soon after the incoming tide, within a period of 1½ hours the salinity had risen to 20·4‰ indicating a very rapid rise. Similarly with the receding tide the fall in the salinity was also rapid being reduced from 22·9‰ at 14·00 hrs. to 8·8‰ at 16·00 hrs.

TABLE V

FLUCTUATIONS IN THE SALINITY OVER THE CLAM BEDS WITHIN A PERIOD OF 12 HOURS (11-8-1961)

Time Hrs.	Salinity Gms/Litre	Tide	Ht. of water Feet	Time Hrs.
06·00	1·4	Low tide	2·9	05·34
08·00	1·4			
10·00	20·4	High tide	13·8	12·22
12·00	22·3			
14·00	22·9			
16·00	8·8	Low tide	5·1	18·30
18·00	8·8			

In order to find out how the clams react to the drastic changes during rainy season, the following experiment was conducted in which changes in salinities as produced by tidal effects were reproduced in the laboratory. For this purpose an aquarium was set up which was filled with four litres of sea water. To this was added fresh water gradually by means of four inlet flows controlled by clamps. The water in the aquarium tank was continuously aerated in order to effect a thorough mixing. The inlet flows, after sufficient trials, were so adjusted that the salinity of water in the tank would come down to 2·0‰ at the end of six hours. After this the process was reversed. The original quantity of water which was increased by addition of fresh water was again reduced to four litres by siphoning extra water. Then instead of fresh water, sea water was added to the tank in the same way as described above, effecting a gradual rise in the salinity in six hours. Ten clams of each species were subjected to this change and their behaviour was studied. As the experiment was in progress a constant watch was kept on the opening and closing of the valves. As soon as the clams either closed or opened, a sample of water from the tank was drawn and the salinity was determined. The results of the experiment are given in Table VI.

TABLE VI

Time		Salinity gm/lt	Behaviour of clams	
			M. meretrix	*K. opima*
		Simulating low tide effect		
0 hr.	9 a.m.	19·3	All opened	All opened
1 hr.	10 a.m.	15·2	,,	,,
2 hrs.	11 a.m.	11·5	,,	One closed
3 hrs.	12 noon	9·4	One closed	All closed
4 hrs.	1 p.m.	6·9	All closed	,,
5 hrs.	2 p.m.	4·4	,,	,,
6 hrs.	3 p.m.	1·8	,,	,,
		Simulating high tide effect		
0 hr.	3 p.m.	1·8	All closed	All closed
1 hr.	4 p.m.	3·9	,,	,,
2 hrs.	5 p.m.	5·4	,,	,,
3 hrs.	6 p.m.	8·9	Two opened	,,
4 hrs.	7 p.m.	11·4	All opened	One opened
5 hrs.	8 p.m.	14·2	,,	All opened
6 hrs.	9 p.m.	18·9	,,	,,

It could be seen from the table that *K. opima* closed their valves indefinitely when the salinity reached 9·4 ‰ whereas *M. meretrix* closed their valves when the salinity reached 6·9 ‰. Similarly *M. meretrix* were first to open up their valves as the salinity started rising. All opened when the salinity rose to 14·2 ‰. However, the opening of the valves, when the salinity was rising, did not take place at the same strength of sea water as was seen when the salinity was falling. Though the valves were closed in the water of 6·9 ‰ in case of *M. meretrix*, for reopening, water of strength 11·4 ‰ was required. Similarly in *K. opima* the valves were opened in water of strength 14·2 ‰ though the phenomenon of closing of valves took place when the salinity was reduced to 9.4 ‰. The difference between the concentration of sea water required for closing and subsequent opening of the valves in case of *M. meretrix* and *K. opima* is 4·5 ‰ and 4·8 ‰, which is approximately the same. It is difficult to explain why higher concentration is required for opening the valves, than the concentration of sea water in which the clams closed their valves indefinitely. It is likely that when the salinity is reducing, the clams with valves open are already circulating water in the mantle cavity and are, therefore, in direct contact with the outside medium. Whereas when the salinity is increasing, the clams are closed and are not in direct contact with the external medium, except perhaps at the edge of the mantle where the stimulus is probably picked up. It is, therefore, likely that some time lapsed before the stimulus reached across the valves to the animal to open the valves. This ' time lapse ' may account for the increase in concentration of the outside medium under experimental conditions. What happens in natural condition is difficult to assess, but as seen above the rise in the salinity is very rapid with incoming tide and " time lapse " felt under laboratory conditions on account of gradual and even rise throughout the period of six hours, is either not felt at all under natural conditions or is greatly minimised owing to very rapid rise in the salinity.

It has been already observed that the effect of acclimatization reduces the lethal salinity to 7·5 ‰ and 5·0 ‰ in case of *K. opima* and *M. meretrix*, respectively. As seen above the closing of the valve takes place in 9·4 ‰ and 6·9 ‰ respectively, in both the species. Therefore, in closing the valves indefinitely at a salinity slightly above the lethal salinity, the animals isolate themselves from the unfavourable environment. Thus, in the mechanism of closing the valves, the clams have found an ideal way to survive unfavourable conditions.

(3) *Efficiency of the valve closing mechanism :*

It has been shown above that in lethal salinities the animals close their valves to isolate themselves from unfavourable environment. But in intermediate salinities the time taken for the valves to open varies with the salinity. It was, therefore, natural to assume that some sort of stimulus must reach the animal, while still closed, by which it then regulates the opening of the valves, opening being delayed as the dilution increases. This stimulus is either reached across the animal on account of slight leakage when the shell valves are apparently closed, or it acts directly on the edge of the mantle.

In order to find out if any exchange of water took place between the mantle water and that of the outside medium when the valves are apparently closed, the following experiment was conducted. The clams from natural sea water were subjected to low salinity (20 ‰) in which both the species do not open their valves for a long time, and samples of mantle water were taken every hour for three hours to see how much dilution had taken place. Two sets of experiments were conducted with each species and the mean values obtained are given in Table VII below :

TABLE VII

Species	Salinity of the mantle water	Salinity of the outside medium	Changes in the salinity of the mantle water owing to immersion in low salinity after......		
	(salinity gm/1t)		1 hr.	2 hrs. (salinity gm/lt)	3 hrs.
K. opima	33·0	7·0	0·40	2·20	3·20
M. meretrix	33·0	7·0	0·40	2·60	3·80

From Table VII, it will be seen that the change in the salinity of the mantle water was only 0·40‰ at the end of the first hour in both the species whereas at the end of the third hour the change was 3·20‰ and 3·80‰, i.e. about 9% and 10% in case of *K. opima* and *M. meretrix*, respectively. Thus it can be said that when the shell valves are closed they provide quite an adequate protection to ward off the unfavourable environment, especially of low salinity against diffusion of water. However, it also follows, on the other hand, that clams are unable to ensure complete closure in nature and prolonged immersion in low salinities would be detrimental.

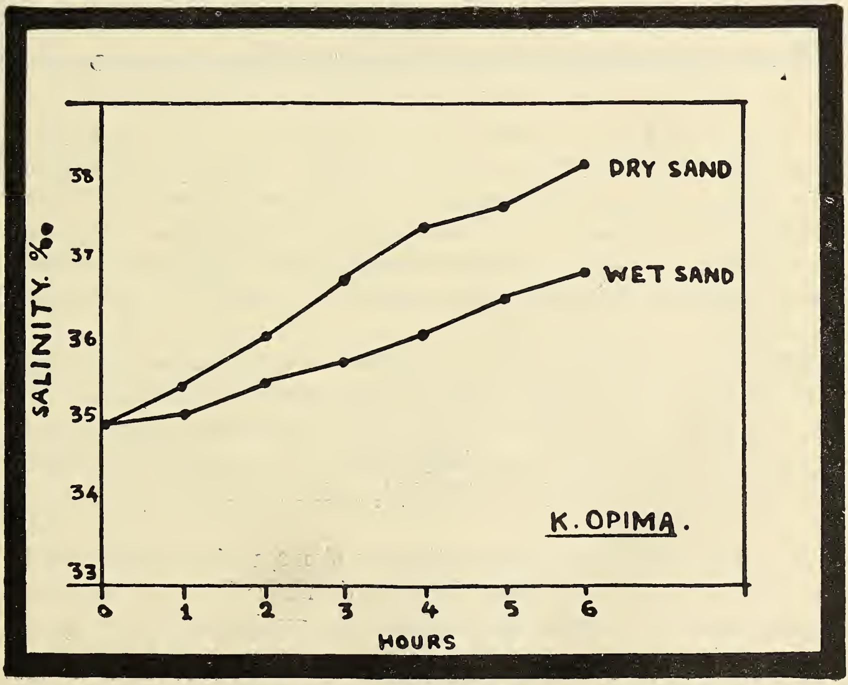

FIG. 6.

When the tide goes out and the clam beds are completely exposed to air the clams in their natural habitat are subjected to desiccation, one more handicap besides low salinities. To study whether there is loss of water from the mantle cavity when the clams are exposed to air, the following experiment was conducted. Two enamel trays were taken and in one a 2 in. thick layer of sand from the Kalbadevi estuary was filled and wetted with sea water, and in the other only dry sand was kept. The idea was to simulate in the first tray a natural condition when the tide runs out, and in the second a rather drastic condition for comparison. Changes in the salinity of the mantle water were determined every hour for a period of six hours. The results of the experiment are given in Table VIII and are represented graphically in figures 6 and 7.

TABLE VIII

	K. opima		*M. meretrix*	
*Hours	Wet sand	Dry sand	Wet sand	Dry sand
1.	35·09	35·54	35·15	35·60
2.	35·54	36·14	35·54	36·20
3.	35·79	36·83	35·79	36·75
4.	36·14	37·53	36·48	37·74
5.	36·48	37·75	36·75	37·80
6.	36·83	38·22	37·54	38·90

* The clams were conditioned in sea water of salinity 35.0 ‰.

From the graphs and Table VIII, it could be seen that there was very little change when both the species were exposed to air, the change being slightly less in *K. opima* than in *M. meretrix*. In wet sand the change in the salinity of the mantle water was 1.83 ‰ in *K. opima* and 2·54 ‰ in *M. meretrix* at the end of six hours, giving an average rate of evaporation of 0·35 ‰ and 0·42 ‰ per hour, respectively. However, the actual rate of evaporation for the first hour was 0·09 ‰ and 0·15 ‰ in *K. opima* and *M. meretrix*, respectively.

When exposed to dry sand, the salinity of the mantle water was, on the whole, slightly higher than in those exposed to wet sand. The rate of evaporation in this case was 0·54 ‰ and 0·65 ‰ per hour in *K. opima* and *M. meretrix* respectively, and the actual rate of evaporation for the first hour was 0·54 ‰ and 0·60 ‰ which was similar to the mean rate of evaporation.

From this, it can be concluded that the clams, under natural conditions of receding tides exposing the beds, do not suffer much from the evaporation of the mantle fluid, and that the mechanism of closing the valves is quite adequate to protect them until such period the tide turns in and covers the beds. From the experiment conducted with dry sand, it may be said that the valve-closing mechanism in these clams is adequate enough to tide over drastic conditions which are rarely met with in the nature.

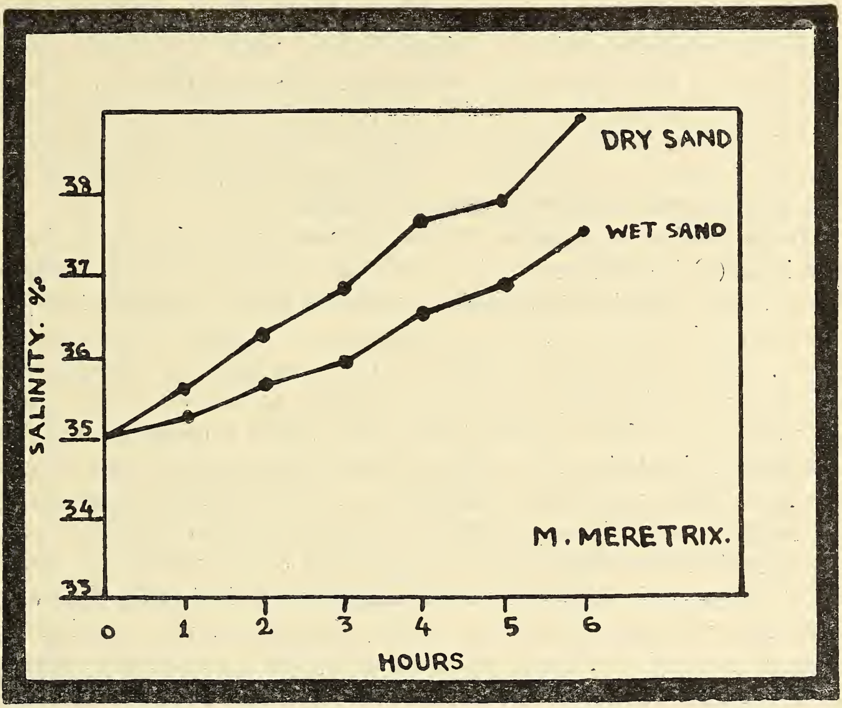

Fig. 7.

(4) *The nature of stimulus which controls the opening and closing of valves :*

In the earlier experiment it was described that the clams when subjected to low salinity (20% sea water and less) do not open their valves. However, when they are transferred back to normal sea water, they open the valves within a few minutes. The question now arises, how does the animal come to know that it is in the right surrounding so as to open the valves for circulating water for breathing and feeding? Since the time taken for the valves to open is progressively delayed with dilution, as shown earlier, it is logical to assume that the sensitivity of the clams to salinity must be due to either change in the ionic concentration of the external medium or the osmotic pressure of the solution to which they are exposed.

Since sodium chloride is the major constituent of sea water, it was considered that either sodium or chloride ions may have effect on the opening of the valves. The experiments conducted are described below :

Taking distilled water as the base, only the sodium ions were raised in the solution to about that of sea water by adding sodium sulphate.

The clams of both the species were subjected to this solution. It was found that the clams did not open up their valves indefinitely in this solution indicating that the sodium ions had no effect on the opening of the valves.

In the second experiment, taking distilled water as the base, only chloride ions were raised by addition of magnesium chloride. Clams subjected to this solution also did not respond and thus it was inferred that chloride ions were also not responsible for causing the stimulus.

Thus it became evident that the ionic concentration of either of the major ions is not responsible for the stimulus.

In the third set of experiments, distilled water was taken as the base, and its osmotic pressure was increased by using a non-electrolite (glycerine). This solution, to be isotonic with sea water, of salinity 34·8‰, was prepared by adding 76·4 cc of glycerine to water to make it up to a litre. When the clams were subjected to this solution, it was observed that they reacted exactly in the same manner as they do so in normal sea water. The clams opened their valves within a couple of minutes and started circulating this solution though there was no trace of any salt in it. This undoubtedly shows that it is the osmotic pressure of the solution which is responsible for the stimulus and not the ionic concentration controlling the initial opening of the valves. It would be interesting to investigate how this stimulus is picked up by the clams when their valves are closed. It is likely that the stimulus is picked up at the external edge of the mantle, perhaps by the contact chemoreceptor cells, but needs thorough investigation.

DISCUSSION

For efficient management of shellfish resources it is necessary to consider several factors, the most important being salinity. The minimum salinity at which the clams can survive and are able to circulate water for feeding must be known and at the same time it is essential to know how long they can survive in unfavourable salinity and what are the factors that affect the length of survival time.

It has been shown above that the two species have different survival values in low salinities. *M. meretrix*, which is more tolerant, survives in as low as 10·5‰, whereas *K. opima* can tolerate only up to 14·0‰ salinity. During monsoon period when saline conditions are lower, the clams get acclimatized to these conditions and become more tolerant to lower salinities. The lethal salinities during this period get reduced to 5·0.‰ and 7·5‰ for *M. meretrix* and *K. opima* respectively. On account of this acclimatization, the clams can survive the salinity dilutions prevalent during the monsoon period. *K. opima* has been observed to survive in pure fresh water for about 60 hours and *M. meretrix* for about 120 hours, both on the basis of 50% survival. This survival period is enhanced during monsoon on account of acclimatization to low salinity. *K. opima* and *M. meretrix* can survive for about 120 and 168 hours respectively. Considering the habitat where these clams are found, this period of survival in fresh water is enough to tide over the unfavourable conditions met with in monsoon. On account of the more tolerant nature, *M. meretrix* has succeeded in penetrating the estuary, whereas *K. opima* is more marine.

The time intervals in opening valves in clams is progressively more as the salinity reduces, and beyond the critical salinity the valves are closed indefinitely so as to withstand the unfavourable environment. In this behaviour also salinity plays an important part in opening and closing of the valves.

There is evidence that the growth in these clams is considerably retarded during the monsoon period. It is, therefore, natural to assume that on account of low salinity during monsoon, the clams are apt to keep their valves closed for longer periods in order to protect themselves from the lethal low salinity, resulting in an inability to circulate water for feeding purpose. However, the process of acclimatization prevents complete cessation of feeding activity during monsoon and the clams are able to feed even at a much lower salinity than the lethal low salinity observed during other periods of the year. It is likely, therefore, that during monsoon clams feed at the high tide only when the salinity is slightly raised on account of influx of sea water, indicating reduction in the intensity of feeding. This may, perhaps, account for the retardation of growth in clams during monsoon.

The valve closing mechanism in the two species of clams has been shown to be an adequate adaptation despite the slight leakage. The desiccation experiments also indicated the same adaptation. Owing to this, clam fishery is supported in an estuary, where the salinity fluctuations are great and where also the animals are at times exposed to air when the tide runs out.

It has been shown above that the clams are sensitive to environmental changes even when apparently closed. There are three possibilities as to how this may happen when the clams are apparently closed.

1. The animals may react to changes in concentration of the mantle fluid which may result through the slight leakage when the valves are apparently closed.

2. The edge of the mantle may act as a semipermeable membrane resulting in osmotic movements of water across it causing an increase or decrease in the hydrostatic pressure in the mantle cavity.

3. The external edge of the mantle which is the only portion likely

to be exposed, may be sensitive to the changes in the salinity or osmotic pressure of the outside medium.

Experiments conducted on clams show that no appreciable change in the salinity of the mantle fluid takes place, at least for quite some time, when the animals are subjected to low salinity. The changes in the concentration of the mantle water, even after one hour, was 0.4 ‰, which is negligible. This rules out the first possibility. Since no appreciable change in the mantle water takes place and since only a minute area of the mantle edge is likely to be exposed to the external environment, the second possibility is ruled out. Experiments conducted to study the effect of changes in the major ionic concentrations such as sodium or chloride have clearly demonstrated that either of the ions had no effect. However, experiments with non-electrolyte showed that the inhibitory stimulus in clams resulted from a change in the osmotic pressure and though there was no trace of salt in the experimental solution, the clams opened up and started circulating the solution. Similar observations have been made by Motwani (1956) in case of *Mytilus edulis* from English coast.

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Reviews

1. LOST LEVIATHAN. By F. D. Ommanney. pp. 280 (24×15·5 cm.). With 8 pages of photographs and many line illustrations. London, 1971. Hutchinson & Co. Ltd. Price £3.

The subtitle of this excellent book is 'Whales and Whaling', and it is a subject on which the author is well qualified to write. For two summer seasons he worked from 5-30 in the morning till 6 in the evening among the blubber, blood and bones of whales ('We dealt with about twenty whales a day on the plan and were kept busy writing up our notes in the laboratory until past midnight'—p. 132); he lived in even closer contact with whale carcasses on the factory ship on which he was inspector, and where he had to protect the absolute alcohol in his laboratory by labelling it 'Formaldehyde 40%—Poison' ('In one instance a whale catcher had to return to harbour because her compass had gone wrong. Someone had removed and drunk the alcohol from it'—p. 175); he has not himself marked whales but has seen many ('From the flight deck of an aircraft carrier off Brisbane in July 1945 we watched dozens of Humpbacks disporting themselves in a sea of purest blue, their white underparts gleaming as they leapt and thrashed around'—p. 42). The handicaps in studying these oceanic monsters are formidable. Marking has already provided some evidence of longevity and migration routes, and perhaps in future surface observations will be supplemented by submarine ones.

The author of SOUTH LATITUDE AND THE OCEAN speaks with authority, humanity, humour and restraint, and this book contains much information, admirably presented and well indexed, about whaling and the anatomy and behaviour of whales. Nearly 55,000 were slaughtered in the peak season of 1937-38, when about 11,000 men were employed in the 'industry'. Today whaling is almost restricted to Humpback and Sei whales in the northern hemisphere and it is to be hoped that the recommendations of the International Whaling Commission, set up in 1946, will save from extinction these great mammals that, some hundred million years ago, took to an aquatic life.

R. E. H.

2. IN THE SHADOW OF MAN. By Jane van Lawick-Goodall. pp. 256 (24·5 × 17 cm.). 11 coloured and 46 black-and-white plates. London, 1971. Collins. Price £2·50.

In recent years we have become accustomed to a high standard of writing in comparative ethology—one remembers for example George Schaller's splendid THE MOUNTAIN GORILLA. One therefore expects a lot from Jane van Lawick-Goodall, more especially because her work has received so much publicity and acclaim, in the *National Geographic Magazine* and elsewhere. One is not disappointed. This is a book for everyone who cares about animals and about man and his origins. It is unique for two reasons. Firstly because, in Dr. Goodall's words, the chimpanzee is:

> '. . . a creature of immense significance to the understanding of man. Just as he is overshadowed by us, the chimpanzee overshadows all other animals. He has the ability to solve quite complex problems, he can use and make tools for a variety of purposes, his social structure and methods of communication are elaborate, and he shows the beginnings of self-awareness.'

Secondly, the book is the result of ten years of continuous observation, of the same individuals in some cases, which has made it possible to study differences between individuals, family relationships, the development of infants, and much else which could not have been discovered in a short-term study.

Jane Goodall went to live in a remote game reserve on the shores of Lake Tanganyika, equipped with no formal training, but with a fascination with and an understanding of animals. She describes vividly the frustrating early months. The wild chimpanzee is a very shy animal and she could obtain only occasional glimpses of them among the branches. Only very slowly did they lose their fear, and when they did it was replaced by aggression. An adult chimpanzee is enormously strong and potentially dangerous; it must have taken considerable courage for the author to stand her ground when attacked. In fact, it must have taken courage from the start to look for chimpanzees, alone in the forest, often spending the night in the open, undeterred by near-encounters with leopards. The rewards came eventually. The chimpanzees accepted her and let her follow close behind them, and there were moments of communion, as when a wild chimpanzee in the forest accepted a fruit from her and briefly held her hand. There is an idyllic quality about those early years of being alone and in harmony with nature which inspires sheer envy in the reader.

By a lucky chance one of the chimpanzees began visiting a fruiting palm near the camp, and started helping himself to bananas as well. A trained behaviourist would probably not have encouraged this, but the author put out bananas regularly and the camp became a feeding station for more and more chimpanzees. This proved to be of the greatest value, since routine observations could be made of individuals who otherwise ranged freely over the forest and were likely to be seen only occasionally. On the other hand, as the author points out, the behaviour of the chimpanzees was altered by feeding—there is a photograph in the *National Geographic Magazine*, not reprinted here, which is reminiscent of the Chimps' Tea Party at the Regent's Park Zoo. The chimpanzees became progressively more demanding and aggressive and, to add to the confusion, troops of baboons began visiting the camp. Moreover, by handling juveniles and making them lose their fear of man the author might have created a dangerous situation for other people when the juveniles attained their full strength. The feeding programme was eventually drastically reduced.

From these beginnings grew the Gombe Stream Research Centre. One of the first people to arrive was the author's husband Hugo van Lawick, who took the excellent photographs reproduced in this book. Students and assistants followed, and it is this team which is responsible for many of the observations described.

Two of the most sensational of Dr. Goodall's discoveries are that chimpanzees make and use tools, previously thought to be a characteristic of man, and that they periodically eat meat, co-operating with each other to hunt and kill small animals as early man must have done.

In common with other animals there is a dominance order among chimpanzees, and the dominant male maintains his position by spectacular charging displays during which subordinate individuals flee. Dr. Goodall describes the rise to dominance of the previously subordinate Mike who most ingeniously learnt to use kerosene tins to make a noise in his displays. He was challenged by the top-ranking Goliath, whose displays became more aggressive as the weeks passed. Finally, after a prolonged duel during which both displayed at each other, Goliath's nerve gave way and he rushed to his opponent, crouched, and began to groom him. Mike ignored him at first, and then in turn groomed his rival. The tension between the two was apparently relieved by friendly physical contact. The importance of physical contact appears again and again. Chimpanzees are quickly roused to aggression, but equally quick to reassure the threatened individual with a touch or an embrace as soon as submission is shown. Adult males spend much of their time in mutual grooming sessions, and a male who is attacked may rush to embrace a friend and, reassured by the contact, may turn and face the aggressor.

Chimpanzees have a long childhood, and families remain together after the birth of new infants. Even adult males spent surprisingly long periods in the company of their mother and her younger offspring. None of the orphans of three years of age or under which were observed survived, even though some were capable of feeding themselves. They all showed signs of depression resulting in physical decline and, though they were adopted by older siblings, only in one case was the adoptive sibling big enough to be able to carry the infant and provide the physical reassurance that a mother would. An interesting situation arises when females in a family become sexually receptive. Normally all the adult males in a group mate frequently with the receptive female. But, in one family observed, neither of the two adult sons mated with his mother, and only rarely with a female sibling, with seeming reluctance on her part although she was the chimpanzee equivalent of a nymphomaniac.

What one remembers ultimately is the personalities of the chimpanzees, and the differences between them. It is the study of these differences and the extent to which they can be related to upbringing that may be the greatest contribution of the Gombe team in the future.

R. R.

3. LIFE IN MUD AND SAND. By S. K. Eltringham. pp. vi+218 (13·5×21·5 cm.). London, 1971. The English Universities Press Ltd. Price £ 1·50 (30 *s.*) net.

Although numerous books have been written on marine ecology, they deal mainly with topics like the open sea or rocky shores. The present work is, therefore, a good beginning to fill up the lacuna on 'depositing' shores, comprising shingle, sand and mud.

The author begins by defining the above three categories and co-relating them with their physical characteristics such as turbulence, slope and area, particle size and interstitial space, etc.

The second, very short, chapter is only a habitat classification of the animals dwelling therein, into epi- and in-fauna, i.e. surface and burrowing/interstitial forms, and further splitting the latter group, by size, into macro-, meio-, and micro-fauna.

He then goes on to elaborating the environmental and behavioural aspects of the two groups; the part on epifauna is restricted mainly to the snail *Hydrobia* and the amphipod *Corophium*, but the infauna is more uniformly treated.

In the chapter on distribution in space, both the horizontal (down-shore) and vertical (depth) aspects are covered. The former is a large area, ranging from the sub-terrestrial to the sub-littoral zones, but the latter is restricted to a depth of a few centimetres by lack of oxygen. The responses of light and pressure in effecting voluntary movements are also described.

The importance of temperature and salinity, both as seasonal and as environmental factors, is stressed. This is in contrast to the rocky fauna, where light and desiccation play a very important part. This is elaborated in a separate chapter on estuarine ecology where, of course, salinity plays an over-riding role.

Since the first seven chapters have elaborated on animals on the shore, with only a superficial coverage on plants, the author has devoted a special chapter to shore plants.

Finally, the author has debated whether the shore can be considered as an ecosystem by itself, or whether it forms only a part of a bigger system.

The book, although in paper-back form, is written in a language which needs an elementary knowledge of biological vocabulary. Moreover, although the author has had wide experience ranging from studying elephants in Africa to wild duck in England, the studies used to exemplify ecological principles in this book are based on animals from temperate regions, and may, therefore, only be limitedly applicable to tropical shores.

Although well edited, a few errors have nonetheless crept in, such as 'being' instead of 'begin' (page 30, line 12), and 'thing' instead of 'thin' (page 49, line 23). Some of the biological names, too, have been misspelt—'Pelycipoda' instead of 'Pelecypoda' (page 40, line 14), 'Gobus' instead of 'Gobius' (page 45, line 33), 'Oxypode' instead of 'Ocypode' (page 65, line 32), and 'Carcinius' instead of 'Carcinus' (page 153, line 8). These however, in no way detract from the otherwise excellence of the book.

B. F. C.

4. THE LIFE OF MAMMALS. Vol. I & II. By L. Harrison Matthews. pp. 340+440 (24×16·5 cm.) with 24 Illustrations and 30 plates. London, 1969, 1971. Weidenfeld and Nicolson.

These two impressively written volumes on the life of mammals fulfil a need for a periodic synthesis for use by the specialists and the non-specialist of the large accumulation of information now available on mammals. An idea of the task involved may be obtained from the fact that the author lists 530 references for the second volume. The two volumes very adequately fulfil this need, written as they are, with impeccable professionalism.

To quote the author volume one of THE LIFE OF MAMMALS discusses various aspects of mammalian life, including among other matters, evolution, adaptations to various habitats, behaviour, reproduction, migration, hibernation, and the ecological relation between man and the other mammals. Volume two reviews the orders and families of mammals with the exception of the primates . . . . and incorporates the latest available information about a large number of the approximately 4200 living species.'

It is difficult to select any section or passage for special mention in the two volumes of such compelling interest. Some vignettes would suffice. Speaking of ethology and behaviour patterns, the author writes of the Common Shrew in England in relation to another species coexisting with it: 'in England there is a second species, the pygmy shrew (*Sorex minutus*) which is much smaller than the common shrew, and lives in the same places. Although both species forage over the same range they never meet or blunder into each other as do individuals of the larger species. Whenever they are about to meet the pygmy shrew realises the presence of the common shrew just before they collide; it instantly avoids the other which is apparently completely unaware of what has happened. As far as the common shrew is concerned the pygmy shrew does not exist—it is as though a race of half-sized human beings inhabited our towns and villages but are so expert in keeping out of sight that we do not know they are there. Perhaps they are.' A theme for Science Fiction at its best.

The last chapter of volume I, *Mammals and Man* is one of the best expositions that I have read of all aspects of man's relationship with other mammals. A very interesting thought is the relationship between coat colour and domesticity. The author points out that 'It is noticeable that nearly all domestic mammals differ in colour from their wild relatives, with a strong tendency to white patches and markings in the coat colour—some are true albinos with pink unpigmented eyes, such as the ferret, rat and some breeds of rabbit.' The remarkable docile white rats are only albinos of the fierce and intractable brown rat. White is indeed the colour of peace and placidity in man also.

An interesting discovery related to inducing placidity is the finding that destruction of the amygdaloid nucleus in a region of the brain connected with the sense of smell makes an animal immediately placid and the author believes that a natural defect of this type may have contributed to domestication.

A strongly recommended reading for all those interested in mammals.

J. C. D.

Miscellaneous Notes

1. A VISIT TO THE SUNDERBANS

I had before a recent visit to the Sunderbans read in the Society's *Journal* **37**:844 (1935) the interesting account on the visit to the Sunderbans written by Vicomte Edmond de Poncins. Unfortunately, not being a knowledgeable or trained observer of nature, it is difficult for me to record anything really useful about changes that may have taken place in the Sunderbans in the last 76 odd years. One or two points may, however, be of interest.

The Vicomte's account indicates that there were absolutely no butterflies throughout the Sunderbans. The position in this respect has certainly changed as we found numerous butterflies of a variety of types everywhere. There were also a very large variety of dragonflies. I am afraid I am not in a position to give the names of the various types of butterflies and dragonflies that I saw. There is also a reference in the old account to the fact that there are no mosquitoes in the Sunderbans. Basically, this is still true although it is of interest that one solitary mosquito was found in a fishing dinghy which we used as transport from our launch to the shore. This was in a place where a certain amount of afforestation work has been undertaken by the West Bengal Government and eucalyptus and casuarina trees have been planted. It seems possible to deduce that such afforestation work is resulting in the ecology of the place slowly changing.

Finally, there is reference in the old account to the fact that, throughout a trip of some six weeks, there was hardly any occasion when a crocodile was not in sight. One of the specific motives behind our trip was to look for crocodile and, in the whole week that we were there, we only saw one and this was at a great distance. One point of interest about the Sunderbans bird life is that it contains vast concentrations of curlew. I would not like to say for certain that the birds were not whimbrels but they certainly looked to me to be the larger curlew. Each morning and in the late afternoon, they used to fly by the launch, sometimes in flocks of over 50. Flock after flock would follow each other and they must have numbered in each area several thousand. As the shooting of these birds—as indeed of all other feathered life—is prohibited, one would have thought that they would not be overly shy. However, it was of interest that the birds never approached within gun shot range of the launch, suggesting that poaching is rife.

C/o MACKINNON, MACKENZIE & CO. PVT. LTD.,
BOMBAY, NAZIR LATIF
November 18, 1968.

2. EXTENSION OF THE RANGE OF *SUNCUS STOLICZKANUS* IN THE RAJASTHAN DESERT

Ellerman & Morrison-Scott (1951) have recognised three subspecies of *Suncus stoliczkanus* Anderson, 1877, namely *S. s. stoliczkanus* (Gwalior, Salsette island, Nimar, Hoshangabad), *S. s. subfulvus* (Kathiawar and Sind), and *S. s. leucogenys* (Ajmer, Rajputana). The last species is based only on one specimen.

During the course of field trips for the ecological survey of the desert rodents (Prakash *et al.*, 1971), we collected this insectivore from three districts, and it was collected earlier from Jodhpur.

Material examined: 1 ♀ from Beechwal, 6 km north of Bikaner—January 1969; 2 ♂♂ and 1 ♀ from Churu—December 1968; 1 ♂ and 1 ♀ from Jhunjhunu—December 1968; 2 ♂♂ and 2 ♀♀ from Jodhpur—1961-62.

Habitat selection: In the north-eastern desert, the shrew was collected from the bases of the thorn-covered mud walls inside as well as on the outskirts of the villages. The general landscape around the villages was sandy plain interspersed with sand dunes. *Suncus murinus* was invariably collected in the same trap lines indicating that both the species of shrews were associated with each other as far as the habitat was concerned. At Jodhpur, however, the small shrew was collected from the burrows of the Desert Gerbil, *Meriones hurrianae* (Jerdon), in sandy plains supporting natural pastures. *Suncus stoliczkanus* were, however, found to be quite uncommon and the frequency of their occurrence in the traps varied from 0·2 to 0·5 shrews/100 traps/24 hours, at the former three localities.

Body measurements: The Rajasthan specimens appear to be smaller in size when compared with *S. s. leucogenys* and *S. s. sub-*

fulvus, on the basis of the measurements given by Blanford (1888-91) and Lindsay (1929). These measurements are summarised in Table below.

TABLE 1

BODY MEASUREMENTS (IN mm) OF *Suncus stoliczkanus*

Body parts	Sex	Rajasthan material *S. s. leucogenys* Range	Rajasthan material *S. s. leucogenys* Mean	after Lindsay (1929) *S. s. leucogenys* Mean	after Lindsay (1929) *S. s. subfulvus* Mean
Head & Body	♂	58-61	59·3	72·0	69·0
	♀	51-58	55·3		
Tail	♂	34-38	36·0	46·0	44·0
	♀	32-38	35·3		
Hind foot	♂	10-12	11·0	11·5	11·0
	♀	10-11	10·6		
Ear	♂	8	8·0	8·5	9·0
	♀	8-10	8·6		

Following Lindsay's (1929) key the shrew is tentatively designated to the subspecies *leucogenys* on the basis of the presence of 1. cinnamon brown colour of the dorsum with reddish tinge, 2. a few whitish hair on the ear, and 3. dirty white coloration of the sides of head—between the angles of mouth and ears—the chin, and part of the chest. The Rajasthan specimens differ from the subspecies *subfulvus* in general coloration of the body and in not having 'strong yellow claws'. The fact remains, however, that Lindsay's key, with respect to this species, is based on the examination of very few specimens and, therefore, it does not appear to be factual. I would, therefore, like to keep the question of subspecies open till a good series of specimens is examined in detail.

The collection of this shrew from the localities mentioned above extends the range of the species further towards north-east into the desert, earlier report being only from Ajmer.

The shrew was identified up to species by the British Museum (Natural History), London and thanks are due to Dr. I. R. Bishop.

CENTRAL ARID ZONE RESEARCH INSTITUTE,
JODHPUR, ISHWAR PRAKASH
May 15, 1972.

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3. COMMUNITY REARING IN *RHINOLOPHUS ROUXI* TEMMINCK 1835 (CHIROPTERA: RHINOLOPHIDAE) IN KFD AREA, SHIMOGA DISTRICT, MYSORE STATE

Considerable information is available on the reproductive cycles of Indian species of Chiroptera, but very little is known about parental care, particularly their behaviour towards nursing the young ones. It has been presumed by bat ecologists that in the majority of species the young ones are carried by their mothers and suckled till they are able to fly (Brosset 1963).

In at least one species, *Miniopterus schreibersi*, Brosset (1962b and 1963) has observed communal rearing. According to him, the young ones are not carried by the mothers during hunting flights, but put together in a special cluster and reared by a community of females. The present communication records a similar observation in a colony of *Rhinolophus rouxi* at Ikkeri village in Shimoga district, Mysore State, India.

While studying the reproductive cycle of *Rhinolophus rouxi* in a colony inhabiting a tree-hollow at Haravadike, a nearby village, we came across adult females in advanced stage of pregnancy, and lactation, during the months of March and April, respectively. The absence of young along with the lactating females in the collections led us to a closer observation in another easily accessible colony inhabiting a latarite tunnel at Ikkeri. The colony was visited on the night of 11 April, 1972, after the majority of bats had gone out of the colony. Approximately a dozen adults were inside the tunnel. A separate compact cluster of young hanging from an area approximately 30 × 30 cm was observed. Seventy heads of the young were counted in an area of approximately 200 sq. cm. On this basis, the total number of young in the cluster was estimated to be approximately 300. Velvety fur had grown on about a dozen young and two of them had already opened their eyes, the rest of were naked. A second observation was made on 12 April during the day, at 11 a.m. With the exception of about a dozen young all were seen attached to the lactating females.

The present observations show that *Rhinolophus rouxi* females leave their young in their day time roost while going out for hunting, instead of carrying them on their body. This is contrary to the recorded observations on this species (Brosset 1962a). The community rearing in *Rhinolophus rouxi* is apparently similar to that of *Miniopterus schreibersi*. Observations on related species may reveal a similar kind of rearing behaviour.

ACKNOWLEDGEMENT

The authors are grateful to the Director, Virus Research Centre, Poona, for his constant encouragement, and to Dr. V. Dhanda for editing the manuscript.

VIRUS RESEARCH CENTRE,
I. C. M. R.
POONA, INDIA,
May 29, 1972.

H. R. BHAT
M. A. SREENIVASAN
G. GEEVARGHESE

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4. ELEPHANTS IN CAPTIVITY IN BURMA

A total of 272 wild elephants were captured during September 1969-May 1970 and 227 were captured during September 1970-May 1971 as per statement below:

	1969-70	1970-71
Kheddah	122	136
Mela Shikar	139	79
Drug immobilisation	11	12
Total:	272	227

Number of Timber Elephants in 1970 is as follows:

State Timber Board	1797
Private owners	4599
Total:	6396

Forest Department:

Baggage Elephants	129

25 Inya Myaing Road,
University P.O.,
Rangoon, Burma,
February 16, 1972.

TUN YIN

5. COLLECTION OF DEER MUSK IN NEPAL

True musk is the dried secretion from the preputial follicles of male musk deer (*Moschus moschiferus* Linn.), distributed in the Himalayan and central Asiatic region. The great demand for this highly prized perfume base has resulted in the near extermination of the species from India though it still flourishes in certain isolated pockets in Nepal, especially in areas bordering the Tibet region of China. The areas where the musk deer is more commonly met with are Bajang and Dhoti, Simikote, Markhor Lekh, forests of western Nepal, Dhorpatan, Manang and Langtang in the central region and Jatapokhri, Thaplegung, Chipwa, Arun valley and Wallingchingola in eastern Nepal. The animal is more frequently met with at altitudes between 3000 m and 4500 m above mean sea level.

The musk is contained in a round to oval gland situated beneath the skin of the abdomen near the naval varying from 5 cm to 10 cm in diameter. The bucks are captured during the breeding season by snaring and trapping, and after killing them the glands are cut off, trimmed and carefully dried. The dried gland is known as 'musk pod' in the trade. The Government of Nepal keeps a strict watch over the collection and only a limited number of licences are issued every year. The high price of the material and its great demand has, however, lured the poacher. I have during extensive tours in the interior regions come across a number of methods practised by poachers Most commonly, dogs are trained to locate the animal through the smell, the musk deer emits during breeding season. A number of such dogs are taken into the forest areas by poachers who roam about in the garb of shepherds. As soon as a musk bearing male is spotted the dogs run after it. The deer has a habit of stopping and looking back after a run of a few hundred metres. The dogs do not overtake it, keep it running till the deer is completely exhausted. The dogs then surround the buck and bark indicating the baying of the victim. The poachers reach the spot and quietly kill the deer and remove the pod. The pods, so obtained, are dried over fire heated stones in obscure corners of the forest. The dried pod quickly change hands so as to make the identification of the culprit impossible.

Another method used is the poisoning of the animal. The musk deer is very fond of the leaves of *Skimmia laureola* S. & Z. (Fam. Rutaceae), which occurs wild in subalpine localities. The poison is applied to the leaves of shrub in areas frequented by musk deer and the kill includes a number of other fauna also.

Poaching is very common in areas bordering Tibet from where the musk is smuggled out to Hong Kong. The musk pods collected under licence are exported from the country under strict quality control. But these undergo varying degrees of adulteration by the exporters and retailers. The musk collected through poaching is almost invariably adulterated with dried blood, minced liver and similar items.

The musk of Nepal origin known in commerce as 'Nepal musk' has a ready market in international trade, the total requirement of which is about 2400 kg per annum. At present the official collections are greatly restricted, though, large quantities worth lacs of rupees are smuggled out through China and Hong Kong as well as through Nepalgunj, Biratnagar and other towns bordering India. The musk deer is becoming rare in other parts of south Asia and there is a great need for the conservation of musk deer in Nepal. In order to maintain sustained supplies, the deer may be reared in regular breeding farms and modern scientific methods employed for separation of musk pod from the animal. In addition, the following forests may be declared as reserved sanctuaries for the musk deer, where its killing and poaching should bear heavy punishment. Such areas are Thakur ji Lekh in Jumla, Kharpu, in Humla and Langtang and Helambu in Baghmati Anchal. The rearing farms may also, preferably be located at these places.

ACKNOWLEDGEMENTS

The author is indebted to His Majesty's Government and the Department of Medicinal Plants, Kathmandu, for providing necessary facilities. Thanks are also due to Shri Y. K. Sarin of the Regional Research Laboratory, Jammu, for helpful criticism and suggestions.

INDIAN CO-OPERATION MISSION,
NEPAL, P. S. JAMWAL[1]
May 9, 1972.

6. ON THE DAILY SCREECHING TIME OF A COLONY OF SPOTTED OWLS *ATHENE BRAMA* (TEMMINCK)

The existence of biological clocks is now a widely known phenomenon and has been studied with numerous organisms at many different levels, ranging from annual reproductive clocks to short cycles at the cellular and molecular level. Several books and reviews (Cloudsley-Thompson 1961, Bünning 1965, Brahmachary 1967, Sollberger 1965) present summaries of the numerous results obtained.

In the present note the authors report the purely observational data on the daily screeching time during emergence in the evening of the Spotted Owlet under natural conditions. The observations comprise data obtained during a period of 138 days extending between 27-viii-67 and 26-ii-68. The rather slight variation in the time of screeching is quite expected in view of the almost universal existence of biological time keepers. Hosking & Newberry (1945) noticed 'how regular the short-eared owls (in England) are in this first visit to the nest with food. Over and over again during several breeding seasons the cock arrived within a few minutes of 8 o'clock.'

We noted the times of emergence and first evening screech over a period of changing seasons, from long days to short winter days lengthening again in the next spring. The observations were carried out in the Indian Statistical Institute garden near Calcutta. The free living spotted owlets lived in a tall tamarind tree (*Tamarindus indicus*). As is well known these owlets generally do not emerge from their hide-outs during daylight although sometimes they are visible and their screechings are sometimes heard at noon or early afternoon. Generally, at about dusk one of the birds suddenly screeched loudly and soon after flew out of its nest or cavity and perched on a branch in a comparatively open space. Sometimes the bird emerged first and called a little later. Other birds of the colony would soon follow. On only 8 days the owls did not call before or shortly after emergence. Here we have noted the screeching time of the first bird. The data show a seasonal maximum variation of 72 minutes, the latest time being 6 minutes past 18 hrs. on 27-viii-67, i.e. the day when the series of observation started, and the earliest being 54 minutes past 16 hrs. on 13-xii-67. The following monthly variations have been noted.

---

[1] Present address: Regional Research Laboratory, Jammu Tawi.

TABLE 1

Month		Latest time	Earliest time	Variation in minutes
September	..	17·57	17·27	30
October	..	17·33	17·08	25
November	..	17·12	17·00	12
December	..	17·18	16·54	24
January	..	17·33	17·13	20
February	..	17·54	17·30	24

It is of some interest to correlate the sunset time with the screeching time. On 14 days in different months the sunset time as published in the newspaper or calendar was compared with the screeching time. With a single exception, when the bird called 19 minutes before sunset, the screeching time was a few minutes after sunset as shown in Table 2.

TABLE 2

THE RELATIONSHIP BETWEEN SUNSET TIME AND SCREECHING TIME.
— AND + SIGNS INDICATE CALL BEFORE AND AFTER SUNSET, RESPECTIVELY.
NUMBERS INDICATE MINUTES.

No. of observations	Relationship with sunset
1	+ 6
2	— 19
3	+ 8
4	+ 8
5	+ 12
6	+ 2
7	+ 13
8	+ 7
9	+ 15
10	+ 15
11	+ 8
12	+ 21
13	+ 13
14	+ 14

We also noted the weather conditions against the calendar dates during the months of observation. It seems that except perhaps for some extreme cases of bad weather the inner clock is more important than the external conditions. If light were the most important factor, on dark overcast days the birds would have called earlier and on bright sunny days the intensity of light would have decreased to that degree at a much later time. Our data show no such correlation between screeching time and weather. The variation in screeching within any month is not due to any such weather conditions. For example, on 13-x-67 the screeching time was 17·20 while the very next day it was 16·35 (the earliest call in this month). On both these days the sky was absolutely clear. During the three months of November, December and January the sky was absolutely clear on all the days of observation so that the daily variations could not be due to weather conditions. On the other hand, the progressive seasonal shortening of days is obviously correlated with the progressively advancing screeching time. This is perfectly understandable because substantial evidence has been collected suggesting that there is an endogenous clock which is regulated by exogenous signals.

INDIAN STATISTICAL INSTITUTE,
CALCUTTA-35,
April 12, 1971.

R. L. BRAHMACHARY
T. K. BASU
A. SENGUPTA

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7. BLACK BULBULS *HYPSIPETES MADAGASCARIENSIS* (P.L.S. MÜLLER) IN DELHI

During February and March 1972 I recorded Black Bulbuls (*Hypsipetes madagascariensis*) on several occasions in natural woodland on the outskirts of Delhi. On February 12th and 14th, and on March 7th two birds were seen, and on March 9th a party of three. All these records were within an area of about 1 sq km. The fact that three birds were together on the last occasion suggests that several groups may have been involved.

According to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN **6**, this species does not normally enter the plains in the western part of its range. No records are mentioned further from the hills than Karnal in Haryana.

The first record occurred only a few days after heavy, and unseasonally late snowfalls in the hills of Himachal and Uttar Pradesh, and this may have been the cause of the unusual influx. Large numbers of Blackthroated Thrushes (*Turdus ruficollis*) also appeared at the same time.

DEPT. OF ZOOLOGY,
UNIVERSITY OF DELHI, A. J. GASTON
DELHI-7,
April 2, 1972.

8. PIED GROUND THRUSH *ZOOTHERA WARDII* (BLYTH) IN KERALA STATE

On 14th March 1972 I was staying at Lower Surianalle Estate, Surianalle P.O., High Range, Kerala (elevation 1676 metres a.s.l.). This tea estate lies on the south-eastern slopes of the High Range, some 20 miles from Munnar. My host Mr. C. R. Brown told me that he had seen, that morning, a party of about six speckled back and white birds about the size of blackbirds which he could not identify.

So on the following morning, 15th March 1972, he and I went to the same shola in which he had observed the birds the day before and we were fortunate enough to see in the very same area about half-a-dozen feeding off small black berries, similar to elder berries. A clear view through binoculars soon revealed that this was a party of Pied Ground Thrush *Zoothera wardii* (Blyth) presumably on their northward passage. Because of the thick undergrowth it was not easy to assess the exact number of birds in the party but I estimate that there were not less than six out of which males and females were in equal numbers.

As the Pied Ground Thrush is apparently rare in this part of Kerala, I have seen only two in the past thirty-seven years, I think this note may be of interest and worth placing on record.

PANDAVARMEDU,
VANDIPERIYAR P.O., M. C. A. JACKSON
KERALA STATE,
April 1, 1972.

9. THE BAYA [*PLOCEUS PHILIPPINUS* (LINN.)] FEEDING NESTLINGS WITH BUTTERFLIES

A number of notes have appeared in the *Journal* on birds attacking or feeding on butterflies. From Darjeeling, Dudgeon (1895), reported the attack of a King Crow (*Dicrurus longicaudatus*) on a male of *Teinopalpus imperialis*. In Kashmir, Nurse (1903) observed attacks on butterflies by Bee-eaters (*Merops viridis*, and *M. apiaster*), Roller (*Coracias indica*), King Crow (*Dicrurus ater*), and he noted that the Bee-eater (*M. apiaster*) ate Lycaenid butterflies probably *Polyommatus boeticus*. Aitken (1904) saw a Bee-eater catch a *Danais*, and a King Crow catching *Euthalia garuda*. From Burma, Hopwood (1926) and Shaw (1927), recorded the attack of the Redlegged Falconet (*Microhierax eutolmus*) on butterflies. The Paradise Flycatcher (*Tchitrea paradisi*) took butterflies (Hubback 1939), and Hopwood (1940), reported from Kathmandu, that 'a Paradise Flycatcher carried a butterfly to its perch, not in its beak but in its feet like a kite'. Sálim Ali, (1946) wrote, 'It is (the Ashy Swallow-Shrike *Artamus fuscus*) one of the few birds that habitually capture and eat butterflies.'

While studying the feeding habits of the Baya Weaver bird in the breeding season (August-October) of 1958, I observed, through a pair of binoculars for the first time a female bringing a butterfly in her bill for feeding the nestlings. She held the butterfly in her beak by its wings and entered into the nest to feed the nestlings. With the help of coloured plates, the butterfly was identified later as belonging to Nymphalidae, (probably *Hypolimnas misippus* ?).

Again in 1959, a female was seen at least six times, bringing butterflies for feeding the nestlings, but the species could not be identified. However, it appears that the female Baya regularly collects butterflies in the Poona region as an item of the nestlings' dietary.

In the terai region of Uttar Pradesh, although all the four species of Indian Weaver birds, namely *Ploceus philippinus*, *P. megarhynchus*, *P. benghalensis*, and *P. manyar* were under observation during four breeding seasons (June-September), I did not observe a single instance of attack on butterflies. Apparently the butterflies were not abundant in the terai region during that season, but on the other hand, other insects were abundant.

It would be interesting if other observers would record their experience on the subject.

174, Kasba Peth,
Poona-2,
June 14, 1972.

V. C. AMBEDKAR

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SHAW, G. E. (1927): Birds eating butterflies. ibid. **32** (2): 377.

10. ORTOLAN BUNTING *EMBERIZA HORTULANA* LINN. NEAR DELHI

On April 18, 1970, at 8.00 a.m. near the village of Mehrauli outside Delhi, we encountered a couple of buntings (*Emberiza* sp.) feeding on stony ground next to some Mughal ruins.

When first seen they were watched for five minutes at a range of about 20 yards while they fed slowly among stones and low vegetation. AJ's immediate reaction was that they appeared to be Ortolan Buntings (*E. hortulana*), a species with which he was familiar in Europe and Turkey, while PJ's comment was that they were unfamiliar to him, although resembling Greynecked Buntings (*E. buchanani*) seen at the spot once before.

We continued to examine them for about 20 minutes at ranges down to about 6 yards. They seemed rather tame and never flew far when disturbed. At one point they were joined by a third bird of the same species. They never perched on any prominence despite the abundance of old walls and boulders available but always landed on fairly open stony ground.

The following description was recorded on the spot. Light conditions were good and we were using 10 × and 8 × binoculars.

Size and shape as in Meadow Bunting (*E. cia*) with long tail and rather short legs, giving low horizontal stance on the ground.

Plumage. Grey head and nape, brown on wings and tail, with pale edges to flight feathers and white outer tail feathers. Edges of greater and median coverts pale, making pale bars. White eye-ring. Bill pink orange, legs orange-flesh. Breast rusty brown shading paler on the belly. Chin pale bordered by pale moustachial streaks, having a faint creamy yellow tint.

One individual, seen at close range for several minutes, showed some brown on back, nape, and cheeks. Heads appeared rather a dirty dull grey in all three individuals.

'Call, only when disturbed, a soft "pt, pt" or "ti-ti-ti-ti".'

On April 19 we again visited the spot at about the same time of the day. We found at least five of the birds present but this time they seemed more wild and after a few minutes observation they flew off in a party and were not seen again. At about 25 yards range the following notes were added.

'Head dull-grey, sullied with brown on mantle, but not olive at all. Seemed grey-brown in some lights. Throat pale cream with slight yellowish tinge on moustachial streaks.'

Breast appears in retrospect to have been rather pale rust colour compared to Ortolan but shape, habits and general coloration were strongly reminiscent of that species. The time of year, however, suggests that the birds should have been in full plumage. The birds that AJ had seen in Turkey in similar plumage were probably already worn, possibly moulting, as the month was July.

Call might be diagnostic (?).

PJ, examined skins of both species from the BNHS. The bill of *E. hortulana* is distinctly thicker at the base and shorter than that of *E. buchanani*, and these features he had noted on the observed birds.

The SYNOPSIS records *E. hortulana* as taken twice in Gilgit and once in Kashmir on Spring migration, and the observation at Mehrauli appears to be the first record on the plains of the subcontinent.

DIRECTOR OF INFORMATION,
WORLD WILDLIFE FUND, MORGES, PETER F. R. JACKSON
SWITZERLAND.

EDWARD GREY INSTITUTE OF
FIELD ORNITHOLOGY, A. J. GASTON
OXFORD, ENGLAND,
March 22, 1972.

11. THE CRESTED BUNTING, *MELOPHUS LATHAMI* (GRAY) IN BHAVNAGAR (SAURASHTRA), GUJARAT

There are not many records of this bird in Saurashtra. I first saw a hen Crested Bunting in the Gir Forest before I wrote my book on the Birds of Saurashtra and subsequently I have seen solitary birds there from time to time.[1] On 13 April, 1972, I saw a hen Crested Bunting in the early morning in my Forest-cum-Wildlife Research enclosure. It was solitary but near a group of Greynecked Buntings (*Emberiza buchanani* Blyth), and it seemed that it had been caught up with this small group. The birds were coming to water; after drinking, they disappeared. This is the first record of this species in Bhavnagar.

DIL BAHAR,
BHAVNAGAR-2,
April 14, 1972.

R. S. DHARMAKUMARSINHJI

12. FIRST RECORD WITH NOTES ON THE TUCKTOO *GEKKO GECKO* (LINNAEUS) FROM THE ASSAM REGION

The last lap of an investigation of the reported occurrence of the Golden Langur in Garo Hills took us on 10th April to the Darugiri Reserve Forest where we camped at the Forest Bungalow. At 6 p.m. a startlingly loud noise from one of the rooms sent us scuttling inside where we discovered a very large spotted lizard hiding in a crevice between the large wooden pillar and the wall, about 12 ft from the floor. Light from our petromax did not seem to scare it visibly; it pressed its body more close to the pillar. The call was again repeated which when syllablised would sound like 'To-khoe', repeated 5 or 6 times. The exertion involved in calling must have been considerable; each time the body lurched forward and the head was raised and lowered. The call gradually decreased in loudness ending in a deep drawn-out guttural. Similar calls were heard from the adjoining forest at intervals. In a bid to make it emerge we removed the petromax and left the lizard in darkness. At 8 p.m. it was seen sitting over the wall of the room but on being disturbed it retreated into the hide-out. The movements were not too agile and much less faster than those of the House Gekko. It took us one hour to capture it alive.

The specimen was identified as *Gekko gecko* (Linnaeus), variously known in literature as Touktai, Tokay, Tucktoo and Taukte lizard. It was a large male. According to Mertens (1960) only males of this species give the familiar call. It measured 310 mm from tip of snout to tip of tail.

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[1] See Shivrajkumar JBNHS 52 : 598—EDS.

Blue slaty grey above, profusely spotted with brick-red and whitish blue spots. Tail with broad, bluish and whitish bands, the blue bands broader than white bands. Lower surface ashy white variegated with grey.

Gut contents were heads and appendages of hymenopterous and lepidopterous insects, elytra and wings of beetles, moths and wasps, and cuticular parts of cephalothorax of arachnids.

The range of this species is North-Eastern India (Bengal, Bihar), Andaman Islands, Indochina, Southern China, Malay Peninsula and East Indian Archipelago (Smith 1935). Annandale (1907) suggested that the occurrence in West Bengal of this species, is by accidental introduction. Such is likely to be the case with the bordering State of Bihar also. We are inclined to believe that its occurrence in the Garo Hills is not fortuitous. We have seen or heard it in many parts of Garo Hills. This Lizard is familiar to Garos by the local name of *To-khoe* and according to them occurs all over the length and breadth of Garo Hills where normally it is a resident in holes in tree trunks in the forested areas. According to folklore *To-khoe* is the monarch of all snakes and is dreaded by Garos who believe that it is extremely venomous and if it bites, no one on earth can save the victim. Apparently the warning coloration may be responsible for this belief.

There are several references in literature about the snake- and bird-eating habits of this gecko. Instances of mortal combat between this lizard and snakes are available particularly from Burma where it is fairly common. Gut contents of our specimen show that it is insectivorous, no vertebrate remains having been discovered. It is likely that like other geckos, *To-khoe* feeds, generally on arthropods and occasionally on vertebrates.

Although it is common inside houses in Bangkok and parts of Burma, it is essentially a denizen of trees in the rest of its range of distribution including India. The fact that our example came from inside the Forest Bungalow is perhaps due to the long period of non-occupation of the building and to its location right inside the Reserve Forest.

The present record extends the known range of distribution of *Gekko gecko* to the north-easternmost part of India and thereby bridges the gulf between the Burma-Malayan countries and India. From the pattern of distribution it is clear that this species is an inhabitant of plains or areas of moderate elevation which explains its absence from the adjoining Khasi Hills where it has not so far been heard or seen.

The home of this lizard appears to be Garo Hills, Burma and Thailand. Insular distribution in Taiwan, Lan Tao, Cebu, Sumba, Jarak and Andaman Islands are all probably due to their accidental introduction probably on ships as it is so in Singapore and Calcutta.

The authors are grateful to the Director, Zoological Survey of India, Calcutta, for facilities.

ZOOLOGICAL SURVEY OF INDIA,
EASTERN REGIONAL STATION,
SHILLONG-3,
April 6, 1972.

R. S. PILLAI
S. K. TALUKDAR

[Since the preparation of this manuscript another example of *Gekko gecko* has been collected from Lakhipur, caught from a crevice on the stem of a banyan tree. Lakhipur is about 30 km from Darugiri (Garo Hills) and is in the Goalpara District very near to its boundary with Garo Hills District. This specimen is smaller (total length 216 mm) and exhibits a few variations in minor details (upper labials 14 on the right and 15 on the left, lower labials 12 on the right and 13 on the left; 18 lamellae under the fourth toe). This example which was not heard calling turned out to be a female on dissection. The stomach contents did not add any new items to the food of this lizard. On enquiry it was gathered that *To-khoe* is not as common as it is in the Garo Hills.]

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13. ON A NEW SPECIES OF THE GENUS *GATERIN* FORSKÅL, 1775 (PISCES: GATERINIDAE) FROM THE ANDAMAN ISLANDS

(*With a text-figure*)

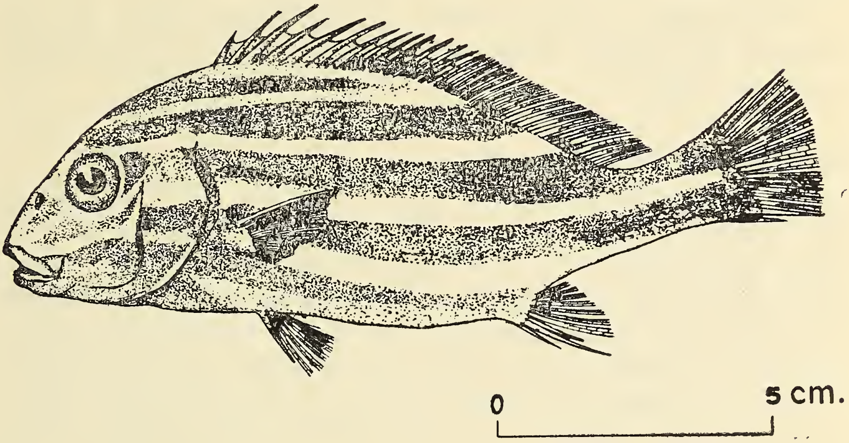
In a collection of fishes from Port Blair (Andaman Islands) collected by Dr. H. C. Ray during 1952, a specimen of an undescribed species of the genus *Gaterin* Forskal, 1775, was discovered. This new species of *Gaterin,* named after the collector, is described here and its affinities discussed.

Gaterin rayi sp. nov.

DESCRIPTION:

D XIV.20; A III.7; P 2,15; V. I.5.

Gillrakers on the first arch 8+20, stout.



Lateral view of the holotype of *Gaterin rayi* sp. nov.

Body deeply ovoid, moderately compressed, depth 2·8 in standard length. Head length 3·2 in standard length; eye diameter 2·9 in head length, nearly equals snout and half in interorbital width. Mouth moderate, slightly oblique, lower jaw shorter than upper, maxillary reaching vertical from front border of eye. Preopercle rectangular serrate. Chin with three pairs of distinct pores.

Teeth—villiform, subequal in both jaws; vomer and palatines also with small villiform teeth, tongue edendate.

Scales—small, ctenoid, extending to front border of eye; snout naked. Bases of vertical fins scaly. Lateral line tubules 68.

Fins—Dorsal scarcely notched, spines moderate, third spine longest, second anal spine strong, longer than third spine, shorter than soft anal rays. Caudal truncate.

Colour in alcohol—Light brown with five longitudinal narrow white bands; first band beginning in the median line on nape to basal part of spinous dorsal, the second from snout above eye to soft dorsal, the third from eye to soft dorsal, the fourth from below eye to end of caudal, and the fifth through pectoral axil to lower part of caudal base. Caudal fin dotted with brown spots.

MATERIAL:

Holotype: a fish 126 mm in standard length; Aberdeen Bay, Port Blair (Andaman Islands); *Coll.* H. C. Ray; 24th March, 1952; Zoological Survey of India, Regd. No. F 6279/2.

Measurements:

Total length 154 mm; standard length 126 mm; depth of body 45 mm; head length 39 mm; eye diameter 13·5 mm; and snout length 14·0 mm.

Relationship:

The new species agrees fairly well with *Gaterin gaterinoides* Smith, 1962 except in the dorsal fin formula (XIV. 20 *vs.* XIII. 20). Smith (1962) observed the dorsal spine number in the various species of *Gaterin* as fairly constant and stressed its importance as a taxonomic character in the family Gaterinidae. Only four species of this genus are known to have the dorsal fin with 14 spines namely, *G. nigrus* (Cuvier & Valenciennes, 1830), *G. paulavi* (Steindachner, 1895), *G. plagiodesmus* (Fowler, 1935) and *G. ceylonensis* (Smith, 1956) (*vide* Day, 1875; Weber & de Beaufort, 1946; Munro, 1955; and Smith, 1962). The new species may be distinguished from the former three species in the dorsal fin formula (D XIV. 20 *vs.* D XIV. 15-16) and from *G. ceylonensis* Smith in having horizontal cross stripes (*versus* uniformly dark) on the body.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-13,
September 7, 1972.

A. G. K. MENON
P. K. TALWAR

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WEBER, M. & BEAUFORT, L. F. DE (1936): The Fishes of the Indo-Australian Archipelago. Leiden, 7: 607.

14. A CASE OF UNPROVOKED ATTACK BY A FISH ON A BOAT

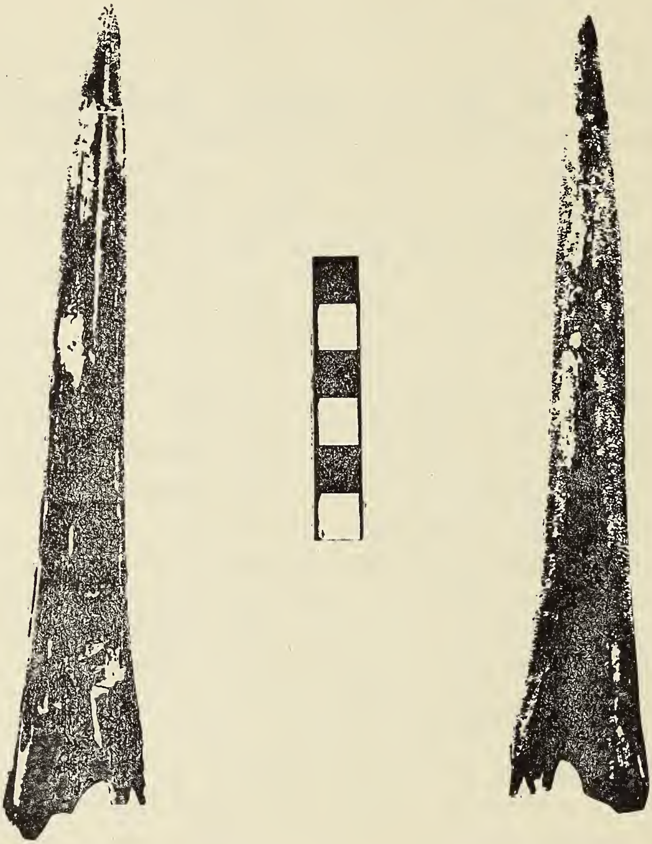
(*With a plate and a text-figure*)

On January 14, 1972, the cargo-boat 'Manik Prasad' of 43 registered tons, was sailing north from Mangalore to Dahanu when, off Karwar in water of 25 fathoms depth, it suddenly sprang a leak, and had to jettison part of its cargo of 30,000 roof tiles. On inspection, a stout bony piece was found firmly embedded in the hull four feet below water line. The boat crew had to sever it with a chopper before they could remove the piece and plug the hole.

The severed piece was sent to the author for detailed examination and was considered to be the snout of a spearfish. It was 407 mm (16 inches) long and weighed 480 gm. The upper surface was smooth, but the lower surface was covered irregularly with white denticles resembling those of sharks. The extreme tip is broken off. probably by the force of impact.

As, after the snout was chopped off, the rest of the fish could not be retrieved, it was difficult to determine exactly which fish caused the damage. Swordfishes, Spearfishes, and Sailfishes all have their upper jaws produced into a snout, and are known to have attacked boats and ships. Misra (1959) records the swordfish [*Xiphias gladius* (Linnaeus)] sailfish [*Istiophorus gladius* (Broussonet)], and spearfish [*Tetrapturus brevirostris* (Playfair)] as occurring in India. Munro (1955) additionally records the marlin [*Makaira mitsukurii* (Jordan & Snyder)] and the Joo-Hoo [*Makaria indica* (Cuvier)] from Ceylon, and these two are also likely to occur in Indian seas. From the rounded cross-secton of the snout, attack by Swordfish (*Xiphias gladius*) could be ruled out, as this fish has its snout flattened like a sword blade, giving the fish its name.

Stories of these fishes attacking boats are not uncommon. Thus, as early as 1674, Josselyn, in his 'Account of two voyages to New Zealand' wrote: 'and in the afternoon we saw a great fish called the Vehuella or Swordfish, having a long, strong and sharp fin, like a sword-blade on the top of its head, with which he pierced our ship, and broke it off with striving to get loose' [Quoted by Jordan & Evermann (1923, p. 293)]. Unfortunately, in most tales of such attacks, no attempt has been made to discriminate between swordfishes, spearfishes, and sailfishes. Schultz & Stern (1948, p. 64) mention an incident involving an attack by a marlin on a Polynesian outrigger canoe at Swain's Island in the South Pacific. Authentic

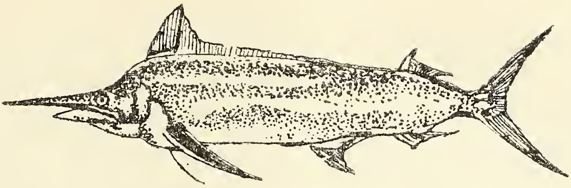


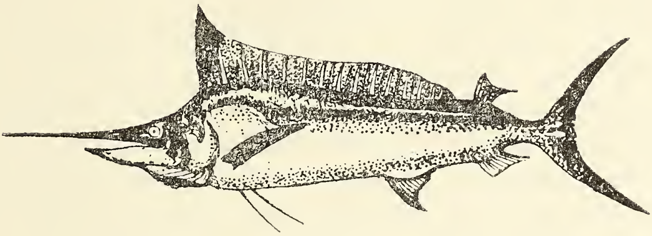
Top (left) and bottom (right) views of snout of spearfish (?) broken off after encounter with a boat. Scale (middle) is in inches.

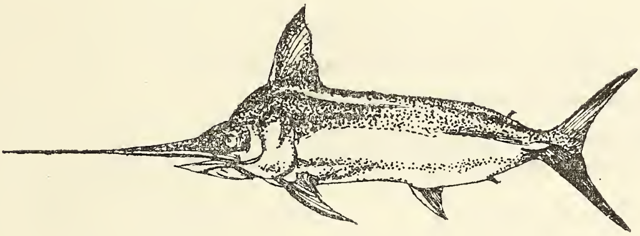
proof of such attacks is furnished by a piece of wood, thirteen and a half inches thick, from the bow of a whaler in which is impaled a 'sword' a foot in length and five inches in circumference, in the museum of the College of Surgeons, London, and a twenty-two inch thick piece of ship's timber with a transfixed snout in the British Museum [Norman (1963), p. 97].

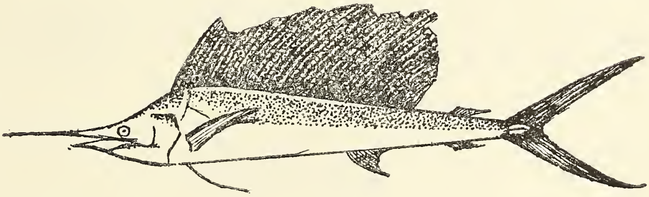
Although attacks through such thick pieces of stout timber might indicate extreme strength and speed on the part of these fishes, Gray (1953) has calculated that it is only apparently so. Thus, for a swordfish weighing 600 lb. and travelling at ten miles per hour, the

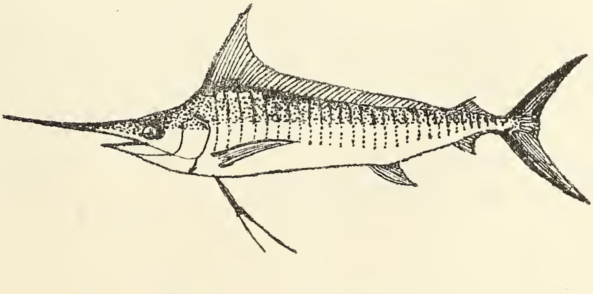
Chhapgar: Unprovoked attack by a fish











For explanation, see reverse

(1) Joo-Hoo—*Makaira indica* (Cuvier).
(2) Spearfish—*Tetrapturus brevirostris* (Play-fair).
(3) Swordfish—*Xiphias gladius* (Linnaeus).
(4) Sailfish—*Istiophorus gladius* (Broussonnet).
(5) Striped Marlin—*Makaira mitsukurii* (Jordan & Snyder).

force applied at the tip of the snout, if it struck a boat moving in the opposite direction at the same speed, would be 4½ tons.

Why these fishes attack boats is only a matter of conjecture. Günther (1880, p. 432) states that swordfishes never hesitate to attack whales and other large Cetaceans, and it may be thought that the fish merely mistakes the ship for a whale. Or it might be that the attacks are due to their pugnacious nature. Harpooned swordfish, according to Perlmutter (1961, p. 352), have been known to attack boats, and as they are unable to execute powerful backward movements they cannot always retract their sword, which is broken off by the exertions of fish to free itself (Günther, *op. cit.*)

Incidentally, Jones (1959), recording a juvenile sailfish (*Istiophorus gladius*) 432 mm long from the Laccadive Sea, states that, 'though adult sailfish are common in the open seas around India and even frequent the coastal waters during certain seasons, juveniles are hardly known. Larval stages ranging in length from 3·40 mm to 11·75 mm were collected from the Laccadive Sea, but all attempts to obtain juveniles met with little success.' Juvenile sailfish are occasionally seen in the markets at Bombay, and a specimen of 435 mm standard length, purchased from Sassoon Docks, Bombay, has been preserved at the Taraporevala Aquarium.

The author is grateful to Mr. A. V. Kulkarni, Superintendent of Fisheries, Thana District, for sending the snout of the spearfish for examination.

TARAPOREVALA MARINE BIOLOGICAL
RESEARCH STATION,
BOMBAY,
June 7, 1972.

B. F. CHHAPGAR

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15. THE RECORD GIANT MORAY EEL, *THYRSOIDEA MACRURA* (BLEEKER)

While examining the landings of the trawler catches at Rameswaram on the south-east coast of India on 20 July 1971, we came across a female giant Moray Eel, *Thyrsoidea macrura* (Bleeker) which measured 3310 mm in total length in the fresh condition and weighed 8·76 kg. The eel was caught at a depth of 5 fathoms off Athankarai (9°21′N., 79°02′E.) by an otter trawl. Though small-sized moray eels are not uncommon on this coast, the larger forms of this species occur only very rarely. It is evident from the published reports that the eel grows to a very large size of about 3 metres in length (Günther 1870; Day 1878; Weber & de Beaufort 1916; Smith 1949). The largest size recorded earlier is 3048 mm in total length by Günther (1870) from Ceylon. The present record of 3310 mm in total length of *T. macrura* from the Indian waters is the longest length reported for this species. Hence a detailed description and body measurements of the specimen are given below.

Thyrsoidea macrura (Bleeker)

Muraena macrurus Bleeker, *Nat. Tijds. Ned.-Ind.*, VII, 1854, p. 324 ; Günther *Cat. Brit. Mus.*, VIII, 1870, p. 127 ; Max Weber, *Nova Guinea* V. Livr. 2, 1908, p. 227.

Thyrsoidea longissima Kaup, *Cat. Apodal Fish—Brit. Mus.*, 1856, p. 82.

Thyrsoidea macrurus Bleeker, *Atl. ichth.*, IV, 1864, p. 111 ; Kner, *Novara Exp. Fische* I, 1869, p. 386 ; Weber & de Beaufort, *Fishes Indo-Aust. Archi.*, III, 1916, p. 355 ; Bal & Mohamed, *J. Bombay nat. Hist. Soc.*, 1957, p. 735.

Muraena macrura Day, *Fishes of India*, 1878, p. 672.

Evenchelys macrurus Jordan & Evermann, *Proc. U.S. Nat. Mus.*, XXV, 1903, p. 327 ; Fowler, *Copeia*, No. 58, 1918, p. 62; Herre, *Philip. J. Sci.*, XXIII, 1923 p. 202 ; *Fishes* 1931 *Philippine Exped.*, 1934, p. 19 ; *Checklist of Philippine Fishes*, 1953, p. 106.

Rhabdura macrura Ogilby, *Proc. Royal Soc. Queensland*, XX, 1906, p. 13 ; Max Weber, *Fische, Sibogo-Expeditie*, 1913, p. 56.

Thyrsoidea macrura Smith, *The Sea Fishes of Southern Africa*, 1961, p. 396 James, *J. Mar. biol. Ass. India*, 1965, p. 401.

Material: One female specimen, 3310 mm in total length weighing 8·76 kg, caught off Athankarai at 5 fathoms and landed at Rameswaram. The specimen is deposited in the Reference collection Museum of the Central Marine Fisheries Research Institute. Reg. No. CMFRI—F. 38/920.

Description: The various body proportions of the preserved specimen are given below:

Head 13·6 in total length, 3·7 in trunk and 4·7 in distance from snout to anus. Height at orbit 102·5 and at anus 41·5 in total length.

Head and trunk 1·9 in tail. Tail 1·5 in total length. Snout 10·1 in head. Eye 30·1 in head and 2·75 in snout. Maxilla 3·2, interorbital 14·2 and gill opening 7·5 in head. Length of dorsal fin 1·05 and length of anal fin 1·55 in total length.

Body very much elongate with laterally compressed head and tail and thicker and rounded trunk. Behind the anus the body height and thickness decrease gradually. Eye much nearer to the tip of snout than to the angle of mouth. Cleft of the mouth wide Maxillary teeth biserial, with 24 teeth in the outer row and 12 in the inner row. Four large fang-like teeth mesially and vomer with a single median row of 8 small teeth. Mandibular teeth also biserial with 22 in the outer row and 10 in the inner row. Anterior tubular nostrils near to the tip of snout while the posterior ones situated just above the anterior margin of eyes. Gill opening oblique in shape, four times diameter of eye. Lateral line composed of interrupted horizontal white tubes extending from just above the gill opening to the end of tail. Dorsal fin originates far ahead of gill-opening. Dorsal and anal fins covered by a thick fold of skin. Pectoral and ventral fins absent.

The body measurements of the specimen are given in Table below.

TABLE

BODY MEASUREMENTS OF *Thyrsoidea macrura* (BLKR.) OBTAINED FROM RAMESWARAM (MEASUREMENTS IN MILLIMETRES)*

Total length (in fresh condition) ..	3310
Total length (in preserved condition) ..	3280
Head length (snout to gill-opening) ..	241
Snout length (tip of snout to front margin of eye) ..	22
Eye diameter (horizontal) ..	8
Eye diameter (vertical) ..	5
Inter-orbital length ..	17
Maxillary length (tip of snout to the end of mouth) ..	75
Length of gill-opening ..	32
Vent length ..	12
Snout to dorsal origin ..	151
Snout to anal origin ..	1163
Snout to anterior edge of vent ..	1133
Length of dorsal fin ..	3129
Length of anal fin ..	2117
Length of tail (posterior edge of vent to tip of tail) ..	2135
Height at orbit ..	27
Height at gill-opening ..	79
Height at anus ..	79
Height at one metre in front of tip of tail ..	69
Height at half metre in front of tip of tail ..	54
Thickness at gill-opening ..	63
Thickness midway between gill-opening and anus ..	66
Thickness at anus ..	60
Thickness at one metre in front of tip of tail ..	45
Thickness at half metre in front of tip of tail ..	26
Origin of lateral line from snout ..	225

* all measurements were taken in preserved condition.

Colour: Body dark brown, sides of head of lighter shade. Fins and tail blackish. About 3 cm wide pale white coloration in the midventral portion of the body.

Distribution: Widely distributed in the tropical and temperate regions of the Indo-Pacific (South Africa, Natal, Ceylon, west and east coasts of India including Andamans, Ceylon, Burma, Malaya, Java, Sumatra, New Guinea, Queensland, Formosa and Palew Islands).

Remarks: The family Muraenidae of the Order Apodes Linne. consists of five genera, of which, the genus *Thyrsoidea* (Kaup) Bleeker is represented by a single species, namely *T. macrura* (Bleeker). This species is easily distinguishable from all other species of the family Muraenidae by its exceedingly elongated form and the tail being twice as long as the trunk. The type specimen *Muraena macrurus* Bleeker collected from Java measures 2½ metres in total length. According to Weber & de Beaufort (1916) this species is 'probably the longest apodal fish in existence'. Smith (1949) is also of the opinion that this eel is 'the longest and possibly the largest known eel growing to over 10 ft. in length'. Recently James (1965) has reported the occurrence of a large specimen measuring 3038 mm in total length, giving some anatomical notes. Comparing the body measurements of our specimen with James's specimen we find the following differences: Eye is 40 in head instead of 30 in head in our specimen. Head and trunk is 1·9 in our specimen whereas it is 2·8 in James's specimen (probably this would have been a misprint for 1·8). In addition to four large fang-like teeth mesially, there is a single median row of 8 small teeth on the vomer in our specimen, whereas in James's specimen, there are only 3 teeth mesially and there is no mention about vomerine teeth. In conclusion it may be stated that the body proportions of our specimen are in full agreement with those of the specimen recorded by Weber & de Beaufort (1916).

REGIONAL CENTRE OF
CENTRAL MARINE FISHERIES,
RESEARCH INSTITUTE,
MANDAPAM CAMP,
August 4, 1971.

R. V. NAIR
K. DORAIRAJ
R. SOUNDARARAJAN

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16. *DELIAS AGLAIA AGLAIA* (LINN.) FROM INDIAN MAINLAND (LEPIDOPTERA : PIERIDAE)[1]

Out of the 13 species comprising 24 subspecies of butterflies in the genus *Delias* Hübn. occurring in the Indian area (Talbot 1939), perhaps there is only one, *D. eucharis* (Drury), which occurs in the plains of India. Others are restricted to the hills and are mostly distributed in the Nepal-Burma Himalayan ranges and hills of Assam.

The Red-base Jezebel, *Delias aglaia aglaia* (Linn.), has so far been recorded from Nepal, Sikkim, Assam (Naga hills) and Burma, at 2000-7000 ft altitude and also from South-West China and Yunnan, according to Evans (1932), Talbot (1939) and Wynter-Blyth (1957). It is reported to be not rare.

One specimen of this butterfly was collected by one of us (R.K.V.) in late December 1968 at Valmikinagar, previously known as Bhainsalotan, in the Champaran Dist. of North Bihar. It undoubtedly belongs to *D. a. aglaia*, and has FW length as 38 mm. The red semi-circular band near the base in UNHW is very conspicuous. The greyish white submarginal stripes in number are as follows—UPFW: 7, UPHW: 5, UNFW: 7, and yellow stripes and spots on UNHW are in the order mentioned by Talbot (loc. cit.).

The specimen probably flew down from the Nepal side, since the mid-stream of the river Gandak forms the Indo-Nepal border in this region, and the towns on the opposite banks are Valmikinagar and Tribenighat. The collection of *D. a. aglaia* in the plains of northern India, is of interest as even in Nepal, this butterfly is not reported from Tribenighat or any other place nearby. Bailey (1951) reported one catch from Devighat in 1935, which is about 90 miles north-east of Tribeni.

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[1] Published with permission from the Director, Zoological Survey of India, Calcutta, for which the authors are grateful to him.

Gangetic Plains Regional Station,
Zoological Survey of India,
Patna-16,
July 21, 1969.

R. K. VARSHNEY
B. NANDI

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17. SOME OBSERVATIONS ON THE HABITS OF THE ANT, *HARPEGNATHUS SALTATOR* FOREL (HYMENOPTERA: FORMICIDAE)

Harpegnathus saltator Forel is a reddish brown ant with a black abdomen, about 2·5 centimetres in length and is characterised by the presence of conspicuously long sickle-shaped mandibles which are slightly curved upwards and articulated at the sides of the somewhat rectangular head. It is not commonly met with because it is crepuscular. The authors collected workers of this species between 5.30 and 6.30 p.m. on the leaf litter in a grove of cashew trees in Irinjalakuda, Kerala State. The workers are generally seen carrying dead insects. They forage mostly alone and sometimes in small groups but are not found moving along definite trails.

The most interesting aspect of the behaviour of this ant is its locomotion. Bingham (1903) in the FAUNA OF BRITISH INDIA, Hymenoptera **2**, states that this ant, when startled or disturbed, makes most astonishing leaps and that it does not leap as a mode of locomotion. In the field, the worker is found to leap occasionally while walkign on uneven ground or among leaves, even when it is not disturbed. As the literature on this ant does not include any details on the locomotion and the mechanism of jumping, the following observations were recorded in the laboratory. The worker generally walks in a characteristic fashion at an average speed of about 2 centimetres per second and after walking for a while, it pauses for about a second and then resumes walking again. The ant can also walk backwards though it does not do so for more than a few centimetres at a time.

When it is disturbed, it leaps suddenly. The approximate height of the jump is 2 centimetres and the distance covered is very variable and may be up to 10 centimetres. The leap is not quite directional from the point of view of the direction of movement of the ant just prior to the leap. The leap appears to be essentially of the somersault type and therefore, on landing, the ant generally faces the opposite direction. The ant almost always lands on its legs. While jumping, the long mandibles are kept close together and their tips are made to touch the ground or any other substratum, thus providing the fulcrum and the long hind legs are used for the leverage during the process. Sometimes, when the jumping mechanism does not fully operate, the ant just falls or is tossed to one side, without covering any forward distance.

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CALICUT 1, KERALA STATE,
August 4, 1969.

A. B. SOANS
J. S. SOANS

18. SOME COCCIDS FROM GOA

As far as I am aware no exploratory report on the coccid fauna of Goa has yet been published. In view of the economic importance of coccids, the first record of six species from Goa presented in this paper is expected to be of use for fundamental and applied studies. The specimens were received from the Collector Shri M. Hayat, Department of Zoology, Aligarh Muslim University, Aligarh, to whom the author extends his sincere thanks.

Family PSEUDOCOCCIDAE

Subfamily Pseudococcinae

Tribe Pseudococcini

Ferrisiana virgata (Cockerell)

1893. *Dactylopius virgatus* Cockerell, *The Entom.* 26 : 178.

Material: Several ex. No. 191M, Vasco-da-Gama, 1 Nov. 1967, from *Lantana camera.*

This species is widely distributed in India and has been recorded on 40 different kinds of plants (Ali 1962).

Nipaecoccus vastator (Maskell)

1894. *Dactylopius vastator* Maskell, *Trans. N.Z. Inst.* 27 : 74.

Material: Several ex. No. 197M, Vasco-da-Gama, 1 Nov. 1967, from unidentified host.

In India it is quite common and has been recorded on 23 different hosts largely fruit plants (Ali 1968a).

Tribe Phenacoccini

Centrococcus insolitus (Green)

1908. *Phenacoccus insolitus* Green, *Mem. Dept. Agri. India, Ent.* 2 (2): 26.

Material: Several ex. No. 192M, Chicolim, 1 Nov. 1967, from *Datura* sp.

This coccid is usually found throughout India on brinjal (Ali, 1968b) but has also been reported on gooseberry (*Physalis maxima*), *Sida cordifolia*, *Abutilon* sp., *Achyranthus* sp., *Tribulus* sp. and *Triumfetta* sp. (Ayyar 1930; Fletcher 1921). It has been observed also on *Malachra capitata* in Coimbatore, on *Achyranthus aspera* in Shoranur, Kerala and on *Wittania somnifera* in Hissar, Haryana (unpublished report by Ali).

Family COCCIDAE

Subfamily Coccinae

Tribe Coccini

Coccus signiferum (Green)

1904. *Lecanium signiferum* Green, *Cocc. Ceylon* **3** : 197.

Material: Several ex. No. 202M, Sanguen, 4 Nov. 1967, on undetermined host.

In India it has been recorded only on plantain leaf (*Musa paradisica* at Golconda, Vizagapatam (Ayyar 1930).

Green (1904) considered this species to be a marked variety of *Coccus hesperidum* (Linnaeus), but recently it has been confirmed by

Boratynski & Williams (1964) that this species is a synonym of *C. hesperidum* (Linn.)

Saissetia hemisphaerica (Targioni)

1867. *Lecanium hemisphaericum* Targioni, *Studii sul. Cocc.* : 26.

Material: 4 ex. No. 204M, Sanguen, 4 Nov. 1967, from unidentified host.

In India it is a sporadic pest of *Citrus* spp and has also been recorded on coffee, tea, fern, etc. (Ali 1968a).

Subfamily Ceroplastinae

Ceroplastes actiniformis (Green)

1896. *Ceroplastes actiniformis* Green, *Indian Mus. Notes* **4** (1) : 8.

Material: Several ex. No. 199M, Madgao, 2 Nov. 1967, from mango.

This coccid has been recorded on the coconut, *Ficus* sp., guava, mango, *Loranthus* sp. and sugarcane (Ali 1968b), further observed on betalnut in Trivandrum (unpublished report by Ali).

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA-13,
February 13, 1970.

S. MOHAMMAD ALI

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19. STUDIES ON SOME PASSALIDS (COLEOPTERA) OF KERALA—II. BIOLOGY AND BIONOMICS OF *BASILIANUS INDICUS* KUWERT AND *B. NEELGHERRIENSIS* PERCH

[*Continued from Vol.* **65** (2): 508]

(*With a plate with thirteen text-figures*)

INTRODUCTION

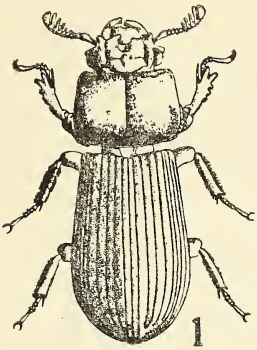
Three species of Passalids bore into the felled timbers in the forest regions of Kerala. These are *Pleurarius brachyphyllus* Stol, *Basilianus indicus* Kuwert and *Basilianus neelgherriensis* Perch. The biology of *P. brachyphyllus* Stol. was presented in the first part of these contributions (Joseph 1968). The biology of the other two species is also similar to that of *P. brachyphyllus*. There, however, exists some morphological differences between the immature stages of the different species. Observations made on these as well as those made on the habits of all the three species are embodied in this paper.

The collection of the different stages and laboratory rearing were done as described earlier by Joseph (1968).

OBSERVATIONS

The Table gives a comparison of the important biological and morphological features of the three species of Passalids. It will be observed that the size of the stages and the duration of the different instars of the two species of *Basilianus* are considerably less than those of *P. brachyphyllus*; there is however no significant differences in these characters between the two species of *Basilianus*.

In *Basilianus* spp. mating lasts for 2 to 3 hours. Preoviposition period lasts for about 2 months under laboratory conditions. In nature, the eggs are laid in the blind ends of the tunnels within the timber, where they are studded on moist blocks of wood powder, in groups of 25 to 30. Generally pupation takes place inside a loose chamber of wood powder. The exuvium of the last instar grub is retained ventrally or at the caudal tip of the pupa. The newly emerged beetle is soft, delicate and pinkish. It attains the proper hardness and oily black colour in about 50 days. Under laboratory conditions the adults survive up to one year. The sex ratio is 1 : 1.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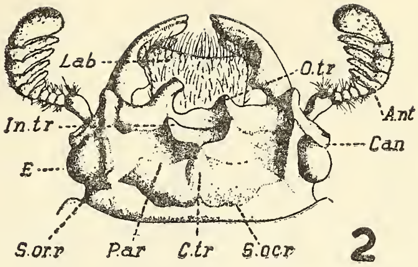
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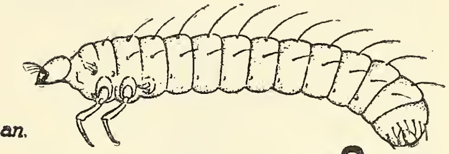
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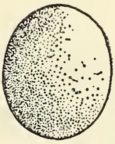
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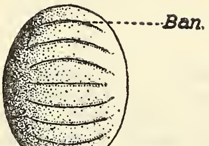

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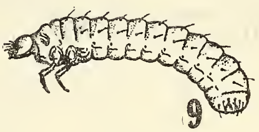
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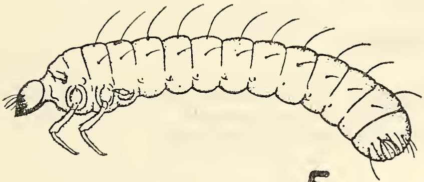
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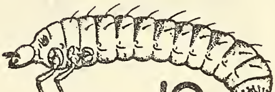
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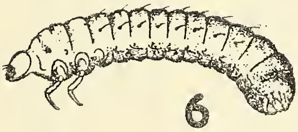
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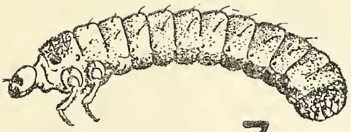
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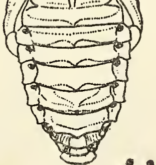
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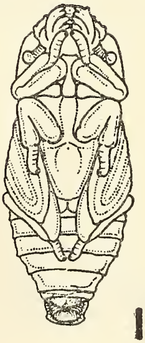
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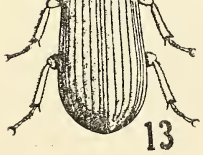
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For explanation, see reverse

FIGS. 1-7, 11-12. *B. indicus* Kuwert: 1. Adult × 1·5; 2. Head × 6; 3. Egg × 6; 4. Egg towards hatching × 6; 5. I instar grub × 3; 6. II instar grub × 1·5; 7. III instar grub × 1·2; 11. Pupa (dorsal view) × 1·5; 12. Pupa ventral view) × 1·5. 8-10, 13. *B. neelgherriensis* Perch: 8. I instar grub × 3; (9. II instar grub × 1·5; 10. III instar grub × 1·2; 13. Adult beetle × 1·5.

Abbreviations

Ant: Antenna; ban: bands; Can: Canthus; C. tr: Central tubercle; E: Eye; In. tr.: Inner tubercle; Lab: Labrum; O. tr.: Outer tubercle; P. ar.: Parietal ridge; S. Ocr.: Supra Occipital ridge; S.Or.r.: Supra Orbital ridge.

TABLE

MEASUREMENTS, DIAGNOSTIC CHARACTERS AND DURATIONS OF THE DIFFERENT STAGES OF PASSALID BEETLES

Stages & Characters	*P. brachyphyllus*	*B. indicus*	*B. neelgherriensis*
Egg			
Colour	Black	Reddish brown—later turns green. 6 to 7 transverse bands are present.	Reddish brown—turning green.
Shape & size	Spherical 4 mm diameter	Ovate—4×2 mm (Figs. 3 & 4)	Smaller than *B. indicus* egg by 1-2 mm
Incubation period	28-34 days	25-30 days	25-30 days
I instar grub			
Length	29 mm	15-20 mm	12-15 mm
Thoracic width	4-5 mm	3-4 mm	3-4 mm
Duration	50-60 days	50-60 days (Fig. 5)	45-50 days (Fig. 8)
II instar grub			
Length	35-40 mm	30-35 mm	25-28 mm
Thoracic width	8 mm	5-6 mm	5-6 mm
Chaetotaxy	Long hairs are clavate. Two long hairs on the 9th abdominal sternum. Large number of small hairs are present on the body	Long hairs are filiform. Sterna devoid of long hairs—Large number of small hairs are present on the body	Sterna devoid of long hairs. Body devoid of small hairs.
Duration	55-65 days	50-60 days (Fig. 6)	50-55 days (Fig. 9)
III instar grub			
Length	48-55 mm	35-40 mm	30-35 mm
Thoracic width	10 mm	8 mm	8 mm
Duration	85-95 days	70-80 days (Fig. 7)	70-80 days (Fig. 10)

Stages & Characters	*P. brachyphyllus*	*B. indicus*	*B. neelgherriensis*
Pupa			
Length	40-45 mm	32-34 mm	22-25 mm
Head width	9-12 mm	7 mm	5 mm
Thoracic width	15-17 mm	11 mm	8 mm
Duration	26-32 days	22-26 days (Figs. 11 & 12)	20-25 days
Adult			
Length	40-45 mm	30-35 mm	15-20 mm
Head width	10 mm	7 mm	5 mm
Maximum abdominal width	18 mm	13-15 mm (Fig. 1)	9 mm (Fig. 13)
Head			
Tip of supra occipital ridge	Slightly concave	Slightly semi-circular	Perfectly semi-circular
Supra orbital ridge	Ends in an acute peak	Ends bluntly	Ends bluntly
Canthus ridge	Sharp	Not prominent	Not prominent
Left outer tubercle	Slightly larger than the right	Produced considerably forward and inward than the right	Slightly larger than the right
Inner tubercles	Symmetrical	Asymmetrical—The right one is larger than the left	Asymmetrical—The left one is larger than the right
Labrum	Anterior end slightly concave	Anterior end deep concave and hairy	Moderately concave
Lacinia	One apical spine and one sub-apical spine	One apical spine alone is present (Fig. 2)	One apical spine alone is present

Habit and Habitat

The passalids under study occur abundantly in the high ranges of Kerala, at altitudes between 1500-7000 ft above sea level. The beetles and their immature stages inhabit felled and partially decayed tree trunks. Their infestations have been recorded from 24 species of timber. The adults make labyrinthine tunnels within the timbers. *B. neelgherriensis* is capable of attacking freshly felled and hard timber also and is rarely found on the erect stumps of felled trees. On an average a beetle can chew down about 1 cubic inch of wood per day.

The grubs are highly sensitive to light and never survive when reared in glass containers. All stages of these beetles occur together within the same tunnels. Gravely (1915) has stated that the larvae of *Pleurarius* and *Basilianus* are generally found widely separated from adults. This is contrary to the observations made during the present study. In fact on very rare occasions the author has seen grubs alone separated from the adults. Different females lay their eggs in the same place within the tunnels and they remain near the egg masses. The different species sometimes occupy the same log. The grubs do not survive when they are put on artificially powdered timber dust. They do not by themselves tunnel within the logs; but they thrive when supplied with adult premasticated wood powder collected from the tunnels. Both the adults and grubs are capable of producing sounds by stridulation. When a log of wood is split or disturbed, the adults run about producing audible sound and the grubs respond by hiding or retreating to the deeper tunnels. All these habits point to an inter-relationship between the adults and their grubs and a definite beginning of social organisation.

ACKNOWLEDGEMENTS

Thanks are due to Dr. C. C. John, former Vice-Chancellor of the University of Kerala, Dr. Chitra Gopalan, Professor, Medical College, Trivandrum and Dr. M. R. G. K. Nair, Professor of Entomology, Agricultural College, Trivandrum, for their interest in the work and for the encouragement.

LECTURER IN ENTOMOLOGY,
MEDICAL COLLEGE, A. JOSEPH
TRIVANDRUM, KERALA,
December 27, 1969.

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20. BORING ORGANISMS OF THE GREAT NICOBAR ISLAND. MOLLUSCA: TEREDINIDAE[1]

INTRODUCTION

The wood borers of the family Teredinidae are chiefly marine and a few of these have been known to occur in brackish water environment also. Some species are found only in brackish water as is the case with most *Nausitora* (Turner 1966). This genus is restricted to tropical and subtropical waters, i.e. Indo-Pacific, Eastern Pacific and Western Atlantic. Altogether, five species are considered valid in this genus by Turner (1966). Of these, *N. dunlopei* was first recorded by Wright (1864) from fresh water below Fureedpore, Comer river, a branch of the Hureegonga which is itself a branch of the Ganges which flows past the towns of Rampore and Pabna. As pointed out by Turner (1966) test-board studies have shown that *N. dunlopei* and *Teredo poculifer* Iredale shift up and down the Brisbane river with changes in salinity. A collection of *Nausitora dunlopei* Wright was made by one of us (A.D.) during the Great Nicobar Expedition from infested dead trees at a place about 25 km up Galathea river in an almost freshwater environment. It was observed to have caused considerable destruction of submerged timber structures in this region.

In the present paper the synonymies, geographical distribution and remarks on the adaptability of this species to environmental salinity changes are dealt with.

Nausitora dunlopei Wright, 1864

1864. *Nausitora dunlopei* Wright: *Trans. Linn. Soc., London* **24**: 453, pl. 46, figs. 1-12

1898. *Calobates fluviatilis*, Hedley: *Proc. Linn. Soc. N.S.W.* **23**: 93, figs. 1-6.

1927. *Bankia* (*Nausitora*) *smithi*, Bartsch: *J. Siam. Soc. nat. Hist. Suppl.* **7** (1): 61, pl. 6, figs. 1, 6-8, 10, 12.

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[1] This paper was presented at the 'Seminar on the achievements of the Scientific Expedition to the Great Nicobar Island' organized by the National Institute of Sciences of India at Varanasi on 2nd January, 1968.

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1928. *Bankia triangularis*, Sivickis : *Philippine Jour. Sci., Manila* 37 : 286, pl. 1, fig. 1.
1928. *Bankia quadrangularis*, Sivickis ; *Philippine Jour. Sci., Manila* 37 : 287, pl. 1, fig. 3.
1928. *Bankia globosa*, Sivickis : *Philippine Jour. Sci., Manila* **37** : 288, pl. 1, fig. 5.
1932. *Nausitora messeli*, Iredale : *Destruction of timber by marine organisms in the port of Sydney, Sydney Harbour Trust, Sydney*, p. 37, pl. 4, figs. 9-12.
1935. *Nausitora schneideri*, Moll : *Sitz., Akad. Wiss. Wien* **144** : 271, pl. 2, fig. 1.
1935. *Nausitora madagassica*, Roch : *Sitz., Akad. Wiss. Wien* **144** : 271, pl. 2, fig. 2.
1935. *Bankia pennamseris*, Roch : *Sitz., Akad. Wiss. Wien* **144** : 274, pl. 2, fig. 4.
1936. *Nausitora queenslandica*, Iredale : *Queensland Forest Service Bull.*, No. 12, p. 37, pl. 2, figs. 8-14.
1954. *Bankia* (*Nausitora*) *madrasensis*, Nair : *Rec. Indian. Mus., Delhi* **52** : 399, figs. 5a-d (1956).

In the above synonymy we have followed Turner (1966) completely with the solitary exception of *N. lanceolata* Rajagopal (1964) since we feel that this species is more closely allied to *N. hedleyi* Schepman which she also considers a valid species.

Material: In addition to the specimens examined *in situ* in the field, preserved specimens were brought back to Calcutta: 2 exs., Sta. 8-25 km up Galathea river, Great Nicobar Island, Coll. No. 698, 27.iii.1966.

Distribution: INDIAN PENINSULA: Fureedpore, Comer river a branch of the Hurreegonga, a branch of the Ganges; Madras-Royapuram; SIAM: Chao Phya river at Bangsorn; PHILIPPINES: Cebu, Dalahican; Cavite, Luzon, Sir J. Brooke Point, Palawan; BISMARCK ARCHIPELAGO: Karlei, Neupommern; FIJI ISLANDS: Rewa and Navua rivers, Viti Levu; AUSTRALIA: Queensland; Chelmer, upper Brisbane river, New South Wales: Port Jackson and Gattai Creek, Hawkesbury river drainage; MADAGASCAR: Port Choisel, Maroantsetra; Vintano auf Sainte-Marie.

This species is restricted to the Indo-Pacific region. In the Indian Ocean it is confined to the tropical limits. However in the Pacific, it extends up to 34°S. lat.

Remarks: The preserved specimens under examination are not full grown, the larger one measuring 27 mm in length.

This is the first record of any Teredinid borer from the Nicobars.

From the locality records of this species (vide supra-synonymy) it is evident that it occurs in fresh, brackish water and marine environments which suggest that it can thrive well under all conditions of salinity dilutions. Further, studies in tolerance of *N. hedleyi* Schepman (Cheriyan 1966) lends support to the view that species of the genus *Nausitora* generally are similarly capable of tolerating wide variations in salinity. It is therefore suggested that this adaptability to such salinity variations in the case of *N. dunlopei* Wright also be taken into consideration and suitable wood preservatives be used while constructing jetties, floating fenders and other submerged timber structures in all types of environments in the Nicobar Islands.

ACKNOWLEDGEMENTS

We are grateful to Dr. A. P. Kapur, Director, Zoological Survey of India, for facilities to undertake this work.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
December 9, 1969.

A. S. RAJAGOPAL
A. DANIEL

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RAJAGOPAL, A. S. (1964): Two new species of marine borers of the genus *Nausitora* (Mollusca: Teredinidae) from West Bengal, India. *J. Bombay nat. Hist. Soc.* **61**: 108-118.

TURNER, R. D. (1966): A survey and illustrated catalogue of the Teredinidae (Mollusca: Bivalvia); 10 unnumbered pp. + 265 pp. — Cambridge, Massachusetts (Museum of Comparative Zoology, Harvard University).

WRIGHT, E. P. (1864): On a new genus of Teredinidae. *Trans. Linn. Soc. London* **24**: 451-454, pl. 1.

21. ON THE NEED FOR CONSERVATION OF THE CAVERNICOLOUS SHRIMP, *MACROBRACHIUM CAVERNICOLA* (KEMP) OF THE SIJU CAVE, GARO HILLS (MEGHALAYA)

Siju Cave is the largest cave that we have in our country. Moreover this is the only cave in India the fauna of which is sufficiently known. S. W. Kemp and B. N. Chopra made a pioneer exploration of the cave dwelling fauna of the Siju Cave in 1922 and their findings were published in the form of a series of papers in the *Records of the Indian Museum* (1924) **26**. Subsequent to this two more parties from the Zoological Survey of India have made faunistic collections from this cave, the first led by Shri A. S. Rajagopal in 1965 and the second by Dr. G. M. Yazdani in 1971. The junior author was with both these parties.

Macrobrachium cavernicola lives in the side pools and stream that flows through the cave and is restricted to the inner parts, from 166 to

1156 metres from the entrance. Out of all the species collected from the cave, this is the only true cavernicolous aquatic animal, all others belong to species also known from outside the cave. It has a white and unpigmented body and the corneal surface of the eye is very much reduced. This shrimp is not known from caves in Burma or any other part of the world. The immense zoological importance of this species is evident from this and the fact that this is the only member of the genus and the only decapod yet known from the Oriental region that shows true cavernicolous adaptations.

Previously the approach to the Siju Cave involved a hazardous boat journey by dug-out canoe through the Someswari River. But a motorable road is under construction along the course of the river connecting Baghmara with Dudhnai. The completion of this road would make the Siju Cave easily approachable by road; one has only to climb down about 180 metres from the road. The government of Meghalaya has recently declared their intention to electrify the cave proper and convert it into a major tourist spot. When this is done the Siju Cave would become a picnic spot and tourist centre and attract many people including excursion parties from schools and colleges. The darkness and fear of the mysterious being no longer there consequent on electrification, more and more people would explore the inside of the cave and would probably collect animal forms as souvenirs. The species is already facing unfavourable conditions. The water they live in is clean and contains little organic matter on which they can feed. They depend for food on the available drowned insects or other animals and the large number of dead shrimps observed is abundant proof that conditions are not normal.

Perpetual darkness is one of the primary factors in the life of cavernicolous animals and introduction of light by artificial lighting, would have far reaching effects on them. *Macrobrachium cavernicola* reacts to light and is attracted to it. This behaviour by itself would lead the species to its doom either from other predatory animals or from the hands of the human visitors or both. In view of all these the Government should devise ways and means of preserving this species. Restricting electrification to the entrance of the cave and imposing legal ban on unauthorised collections shall to a great extent help in its conservation. If not, the only true cavernicolous decapod that we have in our country shall soon be lost to us. The steps taken by the U. S. Department of the Interior to save a species of Mollusc is worth remembering in this context. This species has recently (in

1970) been subjected to the restrictions contained in the Endangered Species Conservation Act of 1969.

EASTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
SHILLONG-3,
September 28, 1971.

R. S. PILLAI
S. BISWAS

22. TWO NEW PLANT RECORDS FOR KASHMIR VALLEY

During the course of exploration of Botanical elements of Kashmir Valley, the following plants were collected, which though already reported from other parts of India form the first records for Kashmir Valley. The specimens are deposited in the Herbarium of Botany Department, Kashmir University, Srinagar.

Tagetus minuta Linn. sp. Pl. 887, 1753; Nair & Pant, *Bull. Bot. Surv. Ind.* **8** (1): 77, 1966.

An autumn flowering, strong smelling, grooved annual herb, variable in height often reaching 3 m; leaves opposite or alternate, often both types on same plant, odd pinnate, 5-15 cm long; leaflets usually 13-17, linear lanceolate, sharply serrate, serrations interrupted, margins dotted with yellowish glands, leaflets 2·5 cm long, filiform dissected lobes near the base of petiole; heads many, crowded together at the ends of branches, 1·2-1·8 cm long; involucre bracts united into a tube with short five free lobes, yellowish green; ray florets usually 2 or 3, rarely 4, pale yellow to almost white, obcordate; disc florets 3-6, deeper yellow, lobes small; acheness linear lanceolate, black 6-10 mm long with appressed golden yellowish hairs; pappus 2-4 mm long of unequal scales.

Locality: University Campus, Gurcharan Singh No. 2836.

Flowering: October-November.

This is a native of South America and probably introduced in India. The plant was first reported from N.W. Himlalayan region of India from several regions, but not from Kashmir, by Nair & Pant (1966). The rapidity with which the plant has spread in the University Campus suggests the possibility of rapid colonisation of the plant in Kashmir Valley.

The plant has also been collected by me from other regions of Jammu & Kashmir State including Kud, Poonch and Swaran Kot.

Solanum xanthocarpum Schrad. & Wendl. Ser-Hanov. 1: 8, t. 2, 1795; C. B. Clarke *Fl. Brit. Ind.* **4**: 236, 1883.

A spreading armed herb; stem prickly, prostrate, branched; rough with hairs at least when young; leaves alternate oblong, pinnatified, 5-10 cm long, armed with prickles on both sides on the mid-rib and veins, prickles pale yellow, straight, 2-4 cm long, petiole 1·5-3 cm long; flower bluish, 2-3 cm diameter singly or in short cymes; calyx prickly, 4-7 mm long, lobes ovate oblong, carolla hairy without, lobes short; fruit a berry, pale yellow with green blotches, 1·2-2 cm in diameter.

Locality: Bank of River Jehlum near tourist reception centre: Gurcharan Singh No. 320a.

Flowers: August-November.

The plant is fairly common all over India usually at altitudes below 1500 m, but often reaching 2400 m. There is however no collection on record from Kashmir Valley.

DEPARTMENT OF BOTANY,
KASHMIR UNIVERSITY,
SRINAGAR,
November 2, 1971.

GURCHARAN SINGH

23. THE HABITAT AND DISTRIBUTION OF *PSILOTUM NUDUM* IN SOUTH INDIA

Though Prain (1894) gives an account of distribution of *Psilotum nudum* (L.) Griseb (Psilotaceae) in India and other parts of the world, the plant was not known from south India till Raizada (1935) recorded its occurrence from Coimbatore, Tirunelveli and Nilgiri districts of Tamil Nadu. Venkateswarlu (1943) reported it from Kakinada (Andhra Pradesh) formerly a part of Madras Presidency. It was not known to occur in other parts of Andhra Pradesh. I collected it in December 1970 during a botanical excursion to Malleswara Kona near Venkatagiri town in Nellore District (Andhra Pradesh). The herbarium specimen (3982 BS) has been deposited in the Visvodaya College Herbarium, Venkatagiri town. While going through the Madras Herbarium of the Botanical Survey of India, Coimbatore, I found that the plant also occurs at Tirupati (M.H. No. 7881, K. Subramanyam) and Visakhapatanam (M.H. No. 28234, G. V. Subba Rao).

A dichotomously branching herb it is generally 20 to 60 cm tall. The plants at Malleswara Kona which were up to 22 cm tall grew in cool and shady places along water courses and in crevices of rocks amidst dense patches of moss of a species of *Vescicularia* (Hypnaceae). *P. nudum* is both terrestrial and epiphytic. The labels of the herbarium sheets of specimens from Kartikeyan (M.H. No. 26863, Sebastine, K. M., & M.H. No. 3945, 12965), indicate that the plant was found as an epiphyte on tree trunks. Shetty, B. V. (M.H. No. 32318) mentions that it was found on a species of *Hydnacarpus*. When terrestrial its growth is stunted (on rocks), and robust in humus.

As the occurrence of this species is both local and rare, a consolidated account of distribution in south India based on the earlier report of Venkateswarlu (1943), herbarium sheets of Madras Herbarium, Botanical Survey of India, Coimbatore and my collection is given below:

ANDHRA PRADESH:—*Visakhapatanam: Chintaladevi; Kakinada: Vatangi; Venkatagiri Town: Malleswara Kona; Tirupati: Papanasam.

TAMIL NADU:—Coimbatore: Irttupalem, *Lower Ponachi, Vellapatty; Madurai: Kodaikanal, Kumbakarai; Nilgiri: Kundah, *Pakasuramalai; Tirunelveli: Courtallam, Mahendragiri hills, Sengalteri; *Kanyakumari: Panagudi.

KERALA:—Kozhikode: Sultan's Battery; *Kottayam: Santanparai.

As against the earlier reports, it will be seen that the plant, though rare, seems to have a wide distribution in south India.

ACKNOWLEDGEMENTS

My thanks are due to Prof. T. S. Mahabale for his valuable suggestions and encouragement; to Prof. C. P. Rao, V. R. College, Nellore, for his keeen interest; to the Director, Botanical Survey of India, Calcutta, for his kind permission to work at the Botanical Survey of India, Southern Circle, Coimbatore.

B. SURYANARAYANA

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* First records.

24. A NEW RECORD OF *CHENOPODIUM* FOR INDIA

Chenopodium carinatum R. Br. Prodr. 407. 1810; Benth. F. Austr. 5: 162. 1870; Bailey, Queensl. Fl. Pt. 4: 124. 1901; Ewart, Fl. Vict. 453. 1930; Merr. & Perry, J. Arn. Arb. 39: 154. 1948; C. A. Backer in Fl. Males. Sr. I. 4: 595. 1954.

A procumbent aromatic annual: stem ascending, much branched; branches ascending, erect; all vegetative parts covered with short glandular hairs. Leaves distinctly petioled, ovate-oblong, obtuse, coarsely dentate, + rugose; lamina 8-22×4-12 mm; petiole 5-10 mm long. Flowers sessile, in axils of nearly all leaves, in small dense rather globular clusters. Tepals 5, pale green but turning white on drying, erect, incurved, narrowly oblong, acute, concave, + 1·25 mm long, + keeled on the back; keels with truncate tips forming stellately spreading wings to the perianth, hairy. Stamen usually 1; ovary eglandular; style rather long, deeply bifid. Fruiting perianth appressed against the fruit but does not conceal it. Fruit erect, broadly oval, compressed, sharply keeled all round. Seed shining, dark brown.

This plant is nearer to *Chenopodium ambrosioides* Linn. but is distinguished from it as follows:

Tepals not or indistinctly keeled on the back ; top of ovary and fruit covered with yellow glands ; stigmas usually 3 or more ; fruiting perianth concealing the fruit.. *Ch. ambrosioides*

Tepals distinctly keeled on the back ; top of ovary and fruit eglandular ; stigmas 2; fruiting perianth appressed against the fruit but not concealing it....... .... *Ch. carinatum*

TAMIL NADU: Nilgiri Dt., on way to Manjari Malai (1450 m). 15-9-1970, *Subbarao et Kumari* 27799 (MH), common near fields in red soil, associated with *Malva sylvestris* Linn.

Distribution: Australia, New Guinea.

The seeds of this plant might have reached Nilgiris Dt. in South India inadvertently by human agency.

BOTANICAL SURVEY OF INDIA,
COIMBATORE,
December 1, 1971.

G. V. SUBBA RAO
G. R. KUMARI

25. SOME INTERESTING PLANTS OF GUJARAT STATE

Papilionaceae

Eleotis monophylla (Burm. f.) DC. (*E. sororia* DC.)

From the distribution range given by Pataskar & Ahuja (*J. Bombay nat. Hist. Soc.* **67**: 127, 1970), it appears that its distribution ranges from South to North India. However the record is incomplete as Gujarat is left out. Our collections from many parts of Gujarat State, namely Rajpipla, Broach, Tuwa, Lunawada, many areas of North Gujarat as far as Ambaji are therefore interesting as they provide evidence of the continuous range of distribution from South to North India.

Moghania lineata (Linn.) O. Ktze. (*Flemingia lineata* Roxb.)

Cooke (Fl. Pres. Bombay 1: 417. 1903) cites locality, Gujarat-Panchmahals on the authority of Dalzell and Dr. Lush ex Graham. Since then, it has not been so far reported from any part of Gujarat. We have collected it (*Vyas* 2013) on 12-i-70 from waste lands between National Highway and broad gauge railway line near the bank of River Narmada opposite Broach town. It was rare.

Tephrosia jamnagarensis Santapau

This species was first reported by Santapau (*Proc. Indian Acad. Sci.* 24B: 133. t. 1. 1958) from Rozi near Jamnagar, Saurashtra.

Our collection seems to be the second report of its occurrence in Gujarat. It was found growing luxuriantly in cultivated fields along narrow gauge line at Broach (*Vyas* 2946) and in open grasslands at Bhadbhut, a small village on Narmada river bank in Broach district (*Vyas* 3095). We have compared our specimens with the type specimen at Blatter Herbarium, St. Xavier's College, Bombay.

Trigonella hamosa Linn. ssp. **uncata** (Boiss. & Noe) Townsend.

This plant was first recorded by Shah, Patel and Patel (*J. Bombay nat. Hist. Soc.* **65**: 260-262, 1968) for Gujarat under *T. uncata*, on the basis of their collection from sandy loam soil in Mahi river bed near Timba Road station in Panchmahal District, East Gujarat. Its collection from the sandy bed of Narmada at Shuklatirth in South Gujarat records a further range of distribution in Gujarat. In the present area, it is a rare plant, 5-7 cm tall. We feel that this species may be found in other parts of Gujarat, if carefully searched for to fill the gaps in its discontinuous distribution in the State.

APIACEAE (UMBELLIFERAE)

***Seseli diffusum** (Roxb. ex Sm.) Sant. & Wagh (*S. indicum* W. & P.).

The species is not given in Cooke's Flora of the Presidency of Bombay (1903), but it is reported by Pataskar & Ahuja (*J. Bombay nat. Hist. Soc.* **67** (1): 126. 1970) from Maharashtra State. We have collected it from Madhi, from Narmada river bed in Broach district, Gujarat State (*Vyas* 5107) on 12-iv-1971. The present record is the first report of its occurrence in Gujarat.

SCROPHULARIACEAE

Mecardonia procumbens (Mill.) Small (*M. dianthera* Penn.).

Thakar (*Indian For.* **97**: 1971) was the first to report it from Hampheswar along the banks of River Narmada in Chhotaudepur Forests in Panchmahals District. According to him, it is a very rare plant restricted only to this locality. The occurrence of this plant is confirmed by the collection of Mr. Y. Y. Karatella (no. 767, 807) the same locality where he also records it as a rare plant. It is however frequently found in cultivated fields and river beds at many places along the banks of River Narmada, and is at times gregarious. Collections were made by *Patel* (Kevadia; 415 1083, 1169, 1425; Kothi 2645, 2620; Garudeshwar, 1060, 2834, 2845) and K. J. Vyas (Shuklatirth, 666; Borbhata 803, 883; Kabirvad, 1574, 2447; Broach 3326, 4106; Mangleshwar 4003; Bhadbhut 4223). From the above localities it appears that, so far, it is distributed in Gujarat only along banks of River Narmada, probably the distribution of the seeds may be by water.

LABIATAE

Orthosiphon glabratus Benth. (*O. tomentosus* var. *glabratus* Hk. f.).

It is listed by Cooke (Fl. Pres. Bombay **2**: 443, 1906) from Gujarat—Pali—on the authority of Woodrow. Mukherjee also cites 'Gujarat' without any specific information on localities of distribution, but it is not reported by any other worker on the flora of different areas of Gujarat State. Therefore, our collection (*Vyas* 2995, 2996) from Kadod in Broach district is confirmatory.

AMARANTHACEAE

Psilostachys sericea Hook f.

Cooke listed it (Fl. Bombay 2: 494, 1906) from Perim Island on the sole authority of Raojee's collection dated 31-viii-1893 without number. This herbarium specimen is available in the Blatter Herbarium, Bombay. Since then this species has not been reported except by Santapau & Janardhanan in *Bull. bot. Surv. India* **8** (Suppl. 1): 43. 1967. There are no specimens of this species in the Blatter Herbarium. One of us collected it from the sandy shores of Juhu Beach near Santacruz, Bombay, on 22-xii-1963 (*Shah* 10665) and these specimens are deposited in the Blatter Herbarium. Recently one of us (*Shah* without number, herbarium specimens and pickled material) again collected it from the sandy shores at Hajira, a health resort about 18 km from Surat, Gujarat State, where it was frequent. These specimens are deposited in Botany department, Sardar Patel University, Vallabh Vidyanagar. The collections of the present authors confirm beyond doubt the occurrence of *Psilostachys sericea* Hook. f. in Maharashtra and Gujarat State. At present its distribution seems to be restricted but a search along coastal region will be worthwhile to note the range of distribution.

ACKNOWLEDGEMENTS

We wish to thank Prof. P. V. Bole, St. Xavier's College, Bombay, for facilities to work at Blatter Herbarium and for allowing us to consult the type specimen of *Tephrosia jamnagarensis* Sant. One of us (KJV) is thankful to the Principal, Jayendrapuri Arts and Science College, Broach, for facilities and encouragement in the work.

DEPT. OF BOTANY,
S. P. UNIVERSITY,
V.V. NAGAR,
GUJARAT, INDIA,
November 29, 1971.

K. J. VYAS
G. L. SHAH

26. *AMARANTHUS POLYGONOIDES* LINN : A NEW RECORD FOR SOUTH INDIA

In the summer of 1969 two plants of the genus *Amaranthus* were collected from a roadside grassy patch near N. S. S. Hindu College, Perunna in Changanacherry, Kerala. These specimens could not be matched with any Indian taxon in the Central National Herbarium, Calcutta. Though resembling *Amaranthus roxburghianus* Nevski (=*A. polygamus* auct. pl. non Linn.) superficially, the specimens were distinct in having five tepals and five stamens. During a visit to the Soviet Union under the Indo-Soviet Cultural and Scientific Exchange Programme, these specimens were matched with authentic material of *Amaranthus polygonoides* L. present in the herbarium of Komarove Botanical Institute, Leningrad.

This taxon is a native of Jamaica and appears to be a new introduction to India and Naik [*J. Bombay nat. Hist. Soc.* **64** (1): 134, 1967; *Indian Forest.* **95** (6): 416, 1969] reported it as a new record for India. As this species is not recorded outside Osmanabad it is thought desirable to place this new locality on record.

The specimens *N. C. Nair* A (May 1969) are deposited in the Central National Herbarium, Calcutta.

ACKNOWLEDGEMENTS

I am thankful to the authorities of Komarove Botanical Institute, Leningrad, for facilities.

76, ACHARYA JAGDISH BOSE ROAD,
CALCUTTA 14,
December 18, 1971.

N. C. NAIR

27. OCCURRENCE OF *DIDYMOCARPUS PYGMAEA* CL. IN RAJASTHAN

Didymocarpus pygmaea Cl., of the family Gesneriaceae, has been recorded previously from Mhowganj (Rewah district), Nimar district, Pachmari, Khandawa, Chota Nagpur and Naga Hills of Assam. Duthie (1903-29) suspected the occurrence of this species in Mirzapur and Bundelkhand. *D. pygmaea* Cl. has not been reported earlier from any locality in Rajasthan, and its occurrence at Kota

Dam (Jawahar Sagar Dam) in Bundi district is a new locality record for the species. A stand of the plant was seen for the first time on the right bank of Chambal river in moist crevices of rocks in April 1969. In August 1969, several such groups were observed on wet exposed rocks.

Didymocarpus pygmaea Cl. is an annual, delicate, pubescent herb. Leaf solitary, sessile, broadly ovate. Flowers yellowish, fascicled in leaf-axil. Calyx-lobes shorter than linear capsules. Fertile stamens 2. Ovary and style villous. Seeds ellipsoid, smooth. *V. Singh* 74719.

The specimen has been deposited in the Herbarium of National Botanic Gardens, Lucknow.

DEPARTMENT OF BOTANY,
J.V. COLLEGE, BARAUT,
MEERUT,
December 12, 1971.

VIJENDRA SINGH

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1971-72

Executive Committee

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Secretary, Ministry of Education, Govt. of India

ex-officio

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Dr. S. K. Mukherjee	*Calcutta*
Mr. R. C. Soni, I.F.S.	*New Delhi*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1971

MEMBERSHIP

There has been some increase in membership during the year under review as these figures will show:

	1970	*1971*
Life Members	174	181
Ordinary Members	703	780
Forest Department nominees	78	80
Student Members	5	5
Honorary Members	3	3
	963	1049

After the closing of accounts on 31st December, 1971, we received 34 subscriptions bringing the total to 1083. We have yet to receive subscriptions from 110 persons who are in arrears, and since many of these members are of long standing it is hoped that most of them would pay their subscription and continue to be our members.

The problem of maintaining close contacts with outstation members continues, and a possible solution has been found by sponsoring the Bihar Branch of the Bombay Natural History Society. The Branch is in the process of being activated, and it is hoped that if this plan works successfully a similar effort can be made in other areas. The advantage of a Branch lies in the fact that members can study local natural history and conservation problems while dealing with these in accordance with the general approach of the Society.

THE SOCIETY'S PUBLICATIONS

Journal: Three issues of the Journal were published during the year; Volume 67 No. 3 and Volume 68 Nos. 1 and 2.

An attempt was made as usual to give a fair coverage to botany, mammals, birds, insects, fishes, crustacea and other invertebrates. The Miscellaneous Notes covered all aspects of natural history. We were happy to be able to arrange for the publication of Mr. M. Krishnan's Report on the Mammals of Peninsular India which he undertook after receiving a fellowship from the Jawaharlal Nehru Memorial Fund. We are particularly grateful to the Seth Purushottamdas Thakoredas and Diwaliba Charitable Trust for a grant of Rs. 15,000 to meet the cost of printing the Report together with relevant photographs illustrating the text.

For financial reasons the size of the Journal will have to be curtailed in future to about 200 pages, and this will mean that the large backlog of articles which have accumulated will be further delayed before publication. Attempts are being made to get financial assistance to meet publication costs.

Books: During the year the following sales were made:

THE BOOK OF INDIAN BIRDS (8th Edition)	1130 copies
THE BOOK OF INDIAN ANIMALS (3rd Edition)	1015 copies
PICTURE POST CARDS	165 sets
SNAKE CHARTS	36 copies

The 9th edition of THE BOOK OF INDIAN BIRDS is now in the press, and we continue our efforts to find financial assistance for reprinting the BUTTERFLIES OF THE INDIAN REGION by M. A. Wynter-Blyth; SOME BEAUTIFUL INDIAN TREES by Blatter; and SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS by Bor and Raizada. We are hopeful that a sponsor will be found soon.

Dr. Sálim Ali and Dr. Dillon Ripley have finished the writing of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, and the first five volumes have been published. The remaining five volumes are progressing well in the press.

CONSERVATION AND SURVEYS

The Society maintains close contact with the International Union for Conservation of Nature and Natural Resources and the World Wildlife Fund as well as the Smithsonian Institution. There are many researchers abroad who would like to be sponsored by the Society to do research work in India. The following list will give an example of the type of proposals we receive:

The Ecology of the Gir Leopard	Chicago University
Comparative Studies in Evolutionary Ecology	Smithsonian Tropical Research Institute
Niche Ecology of the Garden Lizard (*Calotes versicolor*) in the Gir Forest	University of Kansas
Ecology of Indian Crocodiles	New York Zoological Society.

It is recognised that field studies of this kind would be of great value, and assist the formulation of policies for conservation. Unfortunately, the shortage of personnel in the Society as well as the lack of financial resources has made it difficult to progress these proposals adequately. It is hoped that with the appointment of an Assistant Curator many of these projects will be more effectively processed in future.

To create interest in field work among members resident in Bombay, a monitoring programme on the effect of climate on plant and animal life of a small forested valley in the Borivli National Park was undertaken during this year.

BIRD MIGRATION STUDY

The Bird Banding Programme of the Society continues to be the one which generates the largest amount of interest. On several occasions during the year, news about our Bird Banding camps was broadcast over All India Radio. The camps spread out in various areas attract the interest of both specialists and laymen, and apart from the specific purpose of collecting information on their migration routes, this work helps in bringing before the public general information about our birds and their valuable ecological role in the country as a whole. The camp at Bharatpur is particularly popular, and was visited by several officers of the Central Government as well as by a party of scientists from Russia. There is now a proposal to establish a permanent research station at Bharatpur by the Government of India, and the Society is being consulted about this station and the type of projects which it could sponsor.

During the year camps were established at Bharatpur, Point Calimere, Hingolgadh, Mahableshwar, Dachigam Sanctuary and Lammasinghi, and a total of 51,705 birds of about 150 species were banded.

THE GIR PROJECT

During the year the main research work in the Sanctuary sponsored by the Smithsonian Institution and the Yale University was completed. It may be recalled that the objectives were to study the entire ecosystem of the Gir and to arrive at conclusions which would enable effective management practices to be implemented in the interest of the relict population of the lion. The following studies have been undertaken so far:

(1) Behaviour of the Lion, by Paul Joslin.

(2) Grasses of the Gir and the impact of Cattle, by K. T. B. Hodd.

(3) Ecology of the Gir Ungulates, by Stephen Berwick.

Robert Grubh continues with his studies on the role of vultures in the Gir and Nikhil Sanyal is following up the work done on the herbivores by Stephen Berwick.

It is felt that this work needs to be given much more publicity than has been done hitherto, and it is hoped that a Symposium on the research in the Gir will be held later in which the main researchers who have worked in the Sanctuary in the past will all be able to participate.

It must be mentioned that the Government of Gujarat are now taking constructive steps to safeguard the habitat, and to protect the Lion and its prey species. The Maldharis are being gradually relocated outside the Sanctuary, and this by itself will be a major step in rehabilitation of the natural vegetation of the Gir. The Society has been in close contact with the Government of Gujarat, and is happy to have been consulted on various conservation projects.

SÁLIM ALI/LOKE WAN THO ORNITHOLOGICAL RESEARCH FUND

During the year we received a further donation of Rs. 96,805·57 plus interest Rs. 1,864·21 less fellowship paid Rs. 1639·74, and the total now available amounts to Rs. 1,61,636·52. This is a considerable increase from the figure of Rs. 64,606·48 reported last year and is due largely to a very generous donation of £5000 by the Loke Foundation. Other donations received during the year were :

	Rs.
Dorabji Tata Trust	3000·00
Dr. Miss Hamida Saiduzzaffar ..	2500·00
Dr. Sálim Ali	1500·00

The following fellowship was awarded during the year:

Mr. V. S. Vijayan : Rs. 300 per month, plus a contingency grant of a Rs. 2000 annually, for a period of two years.

FAUNA PRESERVATION SOCIETY

We would like to thank the Fauna Preservation Society of London, and particularly its Honorary Secretary Mr. R. S. Richard Fitter, for allowing the Society to retain all the monies collected by way of subscription to its journal ORYX. The money so collected can be used for any conservation project in India approved by the Fauna Preservation Society, and some funds from this account have been used for studying the leopards in the Borivli National Park.

REPRESENTATION ON GOVERNMENT BODIES

One of the most important functions of the Society is to advise Government on natural history and conservation matters, and this it does mainly through its representatives on the following bodies :

Indian Board for Wild Life; National Committee on Environmental Planning and Co-ordination; Indian Standards Institute; Philatelic Society; Tourist Development Council, Government of India; Maharashtra State Wild Life Advisory Board; Maharashtra State National and State Park Advisory Board; Rajasthan State Wild Life Advisory Board; and the Gujarat State Ecology Council.

LIBRARY

During the year 487 books were added to the Library, of which 75 were purchased, 380 were donated and 32 received as review copies for the Journal.

ADDITIONS TO THE COLLECTIONS

During the year 339 specimens were added to the collections:

Mammals	13
Birds	214
Reptiles	70
Amphibians	42

Among these 82 Birds, 5 Mammals, 21 Reptiles and 22 Amphibians were collected at the Bird Migration Study camps.

Interesting additions among the reptiles are the Gekkos, *Cnemaspis indica* and *Dravidogecko annamallensis.*

MEETINGS/EXHIBITIONS

February	: Mr. Sandip Thakore spoke on Some Impressions of Indian and East African Wild Life Sanctuaries.
March	: Dr. Peter Jordan spoke on Ecology and Management of Migratory Mule Deer in California.
April	: Mr. Kantilal Jivan Shah spoke on Seychelles and its Natural History.
June	: Mr. Khisty spoke on National Parks—What they mean to me.
July	: Dr. Allen Tillman spoke to members on Game Cropping and Game Utilization.
August	: Dr. M. D. Parthasarathy spoke on Social Behaviour of the Langur and Bonnet Monkeys.
September	: Sir Hugh Elliott spoke on Conservation of Wetlands and Waterfowl.
	Mr. Stephen Berwick spoke on the Ecology of the Gir Forest.

October : Dr. N. K. Panikkar spoke on New trends in Ocean Research.

November : Dr. S. Dillon Ripley spoke on Ecology and the Developing World.

Mr. K. S. Dharmakumarsinhji spoke on the Great Indian Bustard.

December : Mr. Humayun Abdulali spoke on the Role of the Shikari in Wild Life Conservation.

Mr. S. S. Buit spoke on National Parks of Maharashtra.

Nature Education Scheme

Routine activities under the Scheme such as field-trips for children and teachers, talks and guided tours at the Museum, Zoo and the Aquarium were organised. Seasonal field-trips to study aquatic life and monsoon plants during monsoon term and migratory birds and flowering trees during winter-summer terms were organised in Bombay and Poona.

It is hoped to issue a bulletin ' Young Naturalist ' in English, Marathi and Gujarati for children and teachers to exchange notes and observations of their natural surroundings. A sample issue will be distributed in the current year.

Revenue and Accounts

We reported last year that the financial position of the Society showed a considerable improvement due to the fact that its overheads were partially absorbed by the different field projects. Unfortunately, in spite of the financial assistance from the projects we have not been able to cover the cost of running the activities this year. The accounts show a deficit of Rs. 11,541·23, but since the closing of accounts the normal grant of Rs. 10,000 from the Ministry of Education has been received, and the actual deficit is Rs. 1,541·23.

STAFF

The Committee wishes to record its appreciation of the willing cooperation of the staff in all the activities of the Society.

ACKNOWLEDGEMENTS

The Committee's thanks are due Mr. M. J. Dickins who looked after the Society's affairs in the U.K., and to the members and others who gave help in its field projects and other activities.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET AS AT 31 *DECEMBER*, 1971

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Trust Funds or Corpus :			*Immovable Properties :*		
Life Membership Fund :			*Motor Cars and Motor Cycle :*		
Balance as per last Balance Sheet ..	61,372·79		Balance as per last Balance Sheet ..	38,422·49	
Add : Amount received during the year	4,049·47	65,422·26	*Less :* Depreciation during the year ..	7,684·50	30,737·99
Fixed Assets Fund :			*Furniture, Fixture and Equipment :*		
Balance as per last Balance Sheet ..	85,429·42		Balance as per last Balance Sheet ..	47,006·93	
Add : Donations received during the year	100·00		*Less :* Depreciation during the year ..	5,875·86	41,131·07
	85,529·42		*Investments:* (At cost)		
			Quoted—Shares		
Less : Transferred to Income and Expenditure Account on account of Depreciation for the year ..	13,560·36	71,969·06	107 'A' Equity Shares of Rs. 50 each in Bank of India, fully paid ..	7,541·00	
General Reserve Fund :			95 Equity Shares of Rs. 100 each in Bank of India, Rs. 50 per Share paid up	6,669·00	
Balance as per last Balance Sheet ..		34,015·40			
Carried forward ..		1,71,406·72	Carried forward ..	14,210·00	71,869·06

BALANCE SHEET AS AT 31 *DECEMBER*, 1971—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,71,406·72	Brought forward ..		71,869·06
Building Fund: Balance as per last Balance Sheet ..		9,244·68	*Investments*: (At cost) Brought forward	14,210·00	
			Government Securities—Quoted Rs. 25,000 3% Conversion Loan 1946/86. (Market value 15,000·00) ..	25,000·00	
Publication Fund : Balance as per last Balance Sheet ..		30,725·00	Rs. 2,000 5½% Government of India Loan 2,000 (Market value Rs. 1952·00) ..	2,000·00	
Other Earmarked Funds : (As per Schedule 'A') ..		3,47,909·37		41,210·00	
Provision for Capital Losses : Balance as per last Balance Sheet ..		4,528·38	*Unquoted :* Rs. 3,000 12 Year National Defence Certificates	3,000·00	
Provision for Depreciation on Investments : Balance as per last Balance Sheet ..		6,801·25	*Deposit with :* M/s. Indian Dyestuff Industries Ltd.	1,25,000·00	1,69,210·00
			Loans : (Unsecured, considered good)		
			Loan Scholarships ..	—	
			Other Loans (to staff) ..	120·00	120·00
Carried forward ..		5,70,615·40	Carried forward ..		2,41,199·06

BALANCE SHEET AS AT 31 DECEMBER, 1971—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		5,70,615·40
Liabilities :		
For Expenses	44,476·57	
,, Advance Subscription and other Advances	3,839·22	
,, Sundry Credit Balances ..	17,896·01	
		66,211·80
Carried forward ..		6,36,827·20

ASSETS	Rs. P.	Rs. P.
Brought forward ..		2,41,199·06
Advances : (Unsecured, considered good)		
To Trustees ..	—	
,, Employees (for camp expenses).	10,216·61	
,, Others ..	5,452·82	
		15,669·43
Stocks : (At cost or under)		
Publications	53,398·38	
Process cost of publications ..	3,325.74	
		56,724·12
Income Outstanding :		
Rent	—	
Interest Accrued	9,576.35	
Income-tax	89·00	
Other Income:		
Supplies and Services .. .. (including Rs. nil considered doubtful)	45,583·39	
Indian National Science Academy ..	3,000·00	
		58,248·74
Cash and Bank Balances :		
(*a*) In Current Account with :		
National & Grindlays Bank Ltd., Bombay ..	7,565.83	
National & Grindlays Bank Ltd., London (£599·65) ..	10,793·70	
Chartered Bank, Bombay ..	12,740·99	
Carried forward ..	31,100·52	3,71,841·35

BALANCE SHEET AS AT 31 *DECEMBER*, 1971—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		6,36,827·20	Brought forward ..	31,100·52	3,71,841·35
Notes :			*Cash and Bank Balances*: (Contd.)		
(1) All expenses incurred on the various projects and activities for which specific grant and donations are received have been directly charged to the respective funds account as shown in the schedule annexed to the Balance Sheet.			*In fixed Deposit with :*		
			Bank of India, Bombay (including Rs. 10,000 for Sálim Ali/Loke Wan Tho Ornithological Research Fund and Rs. 3,000 for Col. Burton's Nature Conservation Fund) ..	39,000·00	
			National & Grindlays Bank Ltd., Bombay	20,000·00	
			Chartered Bank, Bombay ..	1,20,000·00	
			Bank of Bhutan, Phuntsholing ..	11,854·51	2,21,955·03
(2) Membership Subscriptions are taken into account on realisation basis. The amounts due as at 31st December 1971 from members is not ascertainable.			*Income and Expenditure Account*		
			Balance as per last Balance Sheet ..	31,489·59	
(3) Contingent liability on partly paid shares Rs. 4,750·00 (Previous year Rs. 4,750.00).			*Add:* Deficit as per Income and Expenditure Account ..	11,541·23	43,030·82
Total ..		6,36,827·20	Total ..		6,36,827·20

As per our report annexed
(Sd.) Habib & Co.,
Chartered Accountants

For Bombay Natural History Society
(Sd.) Zafar Futehally,
Honorary Secretary

For Bombay Natural History Society
(Sd.) J. D. Kapadia,
Honorary Treasurer

(Sd.) G. V, Bedekar,
Chairman, Executive Committee
Bombay Natural History Society

The above balance sheet to the best of our belief contains a true account of the funds and liabilities and property and assets of the trust.
Trustees.

Bombay, *2nd August* 1972

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1971

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
To Expenses in respect of properties :			*By Rent :*		
Rates, Taxes & Cesses		Nil	Accrued	Nil	
Repairs and Maintenance ..		Nil	Realised	Nil	Nil
Salaries		Nil	,, *Interest* (Accrued and Realised) (excluding items directly credited to grants)		
Depreciation (by way of provision or adjustments)		Nil	On Securities	1,070·00	
			On Bank Account (Fixed Deposits) ..	7,873·20	8,943·20
,, *Expenditure from Grants—Government of Maharashtra :*			,, *Dividends* (Net)		404·00
			,, *Donations :*		
For 1970-71 : Salaries, including Dearness Allowance (per contra) ..	9,845·91		In cash	250·00	
For 1971-72 : Salaries, including Dearness Allowance (per contra) ..	26,286·08		In kind	Nil	250.00
For 1970-71 : Building Maintenance (per contra)	1,485·00		,, *Grants :* *Government of Maharashtra :*		
For 1971-72 ; Building Maintenance (per contra)	4,003·92	41,620·91	For 1970-71 (Expended as per contra)	9,845·91	
			For 1971-72 (Expended as per contra)	26,286·08	
			For 1970-71 (Expended as per contra)	1,485·00	
Carried forward ..		41,620·91	Carried forward ..	37,616·99	9,597·20

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1971—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..		41,620·91	Brought forward ..		9,597·20
To Establishment Expenses :			*By Grants* : (contd.) Brought forward..	37,616·99	
Salaries including Dearness Allowance	57,210·21		For 1971-72 (expended as per contra) ..	4,003·92	
Society's contribution to Staff Provident Fund	2,767·00		Educational Activity Grant 1971-72	4,000·00	
Postages	3,392·96		Indian National Science Academy :		
Printing and Stationery	3,225·99		For Journal Publication Expenses 1971-72	3,000·00	48,620·91
Advertisements	39·60		,, *Income from Other Sources :*		
Telephone Charges	1,997·19		Membership Subscriptions ..	31,699·21	
Bank Charges	735·39		Subscribers (non-members) ..	9,817·16	
Meeting Expenses	2,285·42		Student membership subscriptions ..	100·00	
Conveyance, travelling and field trip expenses	395·04		Entrance Fees	667·49	42,283·86
Interest on overdraft	47·21		,, *Publications :*		
Brochure printing	1,008·68		Journal Sales	1,505·50	
Honorary Secretary's report printing for the year 1970	699·60	73,804·29	,, *Profit on sale of Books :*		
To Adult Fees :		1,000·00	Book of Indian Birds	7,152·90	
To Miscellaneous Expenses :			Book of Indian Animals ..	12,097·70	
General Charges	576·66		Identification of Poisonous snake charts	313·50	
Fire and Equipment Insurance ..	173·80		Picture postcards	109·33	
Repairs to Furniture	361·00		Other Publications	2,596·92	
Postage on I.U.C.N. Bulletin ..	61·55	1,173·01	Nature Calendars	12,042·14	
				35,817·99	
Carried forward ..		1,17,598·21	Carried forward ..		1,00,501·97

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1971—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward ..		1,17,598·21	Brought forward ..		1,00,501·97
To Amounts Written off :			*Profit on sale of Books* (contd.) B./f.	35,817·99	
(*a*) Bad Debts	2,242·43		*Less* : Packing and forwarding charges	195·74	
(*b*) Loan Scholarships	Nil				35,622·25
(*c*) Irrecoverable Rent	Nil		*By Miscellaneous Receipts :*		
(*d*) Other Items	Nil	2,242·43	(including Rs. 6,000 compensation from World Wildlife Regional Office, Bombay)		14,266·73
,, *Depreciation :*					
On Investments	Nil		Administrative fees for handling various project grants during the year, debited to the respective grants/funds		13,906·77
On Furniture	5,875·86				
On Motor Cars	7,684·50	13,560·36			
,, *Expenditure on Objects of the Trust :*					
(*a*) Religious	Nil				
(*b*) Educational—Journal Expenses (including indices)	50,176·05		,, *Transfers :*		
Library Account :			From Fixed Assets Fund on account of Depreciation (as per contra)		13,560·36
Subscription to other Societies ..	1,470·95				
Purchase of books	492·30				
Periodicals and binding charges ..	295·25		Deficit carried over to Balance Sheet		11,541·23
Library & other maintenance ..	418·60	52,853·15			
,, *Maintenance of Reference Collections* ..		3,145·16			
Total ..		1,89,399·31	Total ..		1,89,399·31

As per our report of even date.
(Sd.) HABIB & Co.,
Chartered Accountan

BOMBAY, 2*nd August* 1972

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 DECEMBER, 1971

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Returned during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1971 (5 minus 8)* (9)
(1) Field Work Fund ..	289·04	..	..	289·04	..	..	..	289·04
(2) Staff Welfare Fund ..	2,220·69	..	..	2,220·69	..	..	..	2,220·69
(3) Dr. Sálim Ali/Loke Wan Tho Ornithological Research Fund	64,606·48	98,669·78 (including interest Rs. 1,864·21)	..	163,276·26	1,639·74	..	1,639·74	161,636·52
(4) Col. Burton's Nature Conservation Fund ..	4,020·90	217·15 (interest)	..	4,238·05	..	..	..	4,238·05
(5) Grant from California Academy of Science for Herpetological Survey ..	1,306·73	..	..	1,306·73	402·09	..	402·09	904·64
(6) Vertebrate Zoology Field Work Fund (By Shri Humayun Abdulali) ..	14,939·70	..	..	14,939·70	541·15	..	541·15	14,398·55
(7) Grant from Seth Purushottamdas Thakoredas and Divaliba Charitable Trust for the Publication of Nature Study booklets for Free Distribution ..	14·16	..	..	14·16	..	14·16	14·16	..
(8) Grant from Seth Purshottamdas Thakoredas and Divaliba Charitable Trust for the publication of Sri M. Krishnan's Mammal Survey Report ..	..	15,000·00	14·16	15,014·16	..	..	..	15,014·16
Carried forward ..	87,397·70	113,886·93	14·16	201,298·79	2,582·98	14·16	2,597·14	198,701·65

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ Returned during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December, 1971 (5 minus 8)* (9)
Brought forward Rs. ..	87,397·70	113,886·93	14·16	201,298·79	2,582·98	14·16	2,597·14	198,701·65
(9) Grant from Smithsonian Institution for the Secretarial Assistance to Dr. Sálim Ali on the Publication of Handbook of the Birds of India and Pakistan in Ten Volumes ..	191·92	25,000·00	..	25,191·92	12,249·61	..	12,249·61	12,942·31
(10) Grant from Smithsonian Institution for the Bird Migration Study Survey ..	..	174,040·00	..	174,040·00	146,170·73	146·28	146,317·01	27,722·99
(11) Grant from His Majesty King of Bhutan for the publication of Birds of Bhutan by Dr. Sálim Ali ..	11,240·02	724·26 (interest)	..	11,964·28	..	..	..	11,964·28
(12) Grant from Yale School of Forestry for Gir Forest Ecological Research Programme	58,045·88	180,538·00	..	238,583·88	178,891·41	..	178,891·41	59,692·47
(13) Grant from Smithsonian Institution for Gir Forest Ecological Research Programme ..	18,074·38	35,340·00	..	53,414·38	41,894·15	..	41,894·15	11,520·23
(14) Grant from World Wildlife Fund for the publication of a Booklet on Conservation..	20,000·00	..	..	20,000·00	16,975·42	..	16,975·42	3,024·58
Carried forward ..	194,949·90	529,529·19	14·16	724,493·25	398,764·30	160·44	398,924·74	325,568·51

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward Rs. ..	194,949·90	529,529·19	14·16	724,493·25	398,764·30	160·44	398,924·74	325,568·51
(15) *Grant from Government of Maharashtra :*								
(1) Grant for 1970-71 :								
(*a*) For Establishment expenses ..	10,480·20	..	..	10,480·20	634·29[1] 9,845·91	..	10,480·20	..
(*b*) For Building Maintenance ..	1,523·85	..	..	1,523·85	1,485·00 38·85[1]	..	1,523·85	..
(2) Grant for the year 1971-72 :								
(*a*) For Establishment expenses ..	..	35,764·00	..	35,764·00	26,286·08	..	26,286·08	9,477·92
(*b*) For Building Maintenance ..	..	6,000·00	..	6,000·00	4,003·92	..	4,003·92	1,996·08
(16) Dr. Sálim Ali 75th Birthday Fund ..	..	10,866·86	..	10,866·86	..	..	..	10,866·86
Total ..	206,953·95	582,160·05	14·16	789,128·16	441,058·35	160·44	441,218·79	347,909·37

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[1] The relevant amounts being unspent have been refunded to the relevant Grantee/Government Authorities.

[2] Amount refunded to Bombay Natural History Society in respect of the amount spent by them in the previous year.

As per our report of even date
(Sd.) HABIB & Co.,
Chartered Accountants

BOMBAY, 2*nd August*, 1972

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the Year ended 31 *December* 1971

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1971			By Salary of Nature Education Organiser		7,236·00
National & Grindlays Bank Ltd., Bombay, on Current Account ..		9,185·86	,, Printing and Stationery ..		634·71
			,, General Charges		1,284·53
,, Grant from Government of Maharashtra for 1971-72		9,236·00	,, Postages		120·85
			,, Balance as at 31st December, 1971		
,, Sales of Nature Study Booklets ..		230·34	National & Grindlays Bank Ltd., Bombay, on Current Account ..		9,377·11
,, Balance carried forward being advance from Bombay Natural History Society		1·00			
Total ..		18,653·20	Total ..		18,653·20

As per our report annexed
(Sd.) HABIB & Co.,
Chartered Accountants

BOMBAY, 2*nd August*, 1972

BOMBAY NATURAL HISTORY SOCIETY

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH GRANT-IN-AID

Receipts and Payments Account for the Year ended 31 *December* 1971

RECEIPTS		Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1971 :			By Grant for the Study of Ecology of Avian Species of importance to Indian Agricultural Economics 1970-71 :		
With National & Grindlays Bank Ltd., Bombay, on Savings Account ..	1,329·77		Salaries	600·00	
With Junior Fellow (Mr. D. N. Mathew)	500·00	1,829·77	Miscellaneous	545·50	1,145·50
,, Interest on Bank Account		16·00	Unspent Grant-in-Aid refunded to the Council of Scientific and Industrial Research, New Delhi		305·65
			Unspent Grant-in-Aid refunded to Agricultural Research ..		83·08
			,, Balance as at 31st December, 1971 :		
			National & Grindlays Bank Ltd., Bombay, on Savings Account..		311·54
Total ..		1,845·77	Total ..		1,845·77

As per our report annexed
(Sd.) HABIB & Co.,
Chartered Accountants

BOMBAY, 2*nd August*, 1972

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 1, ON THURSDAY, 31ST AUGUST, 1972, AT 6.00 P.M., WITH MR. R. E. HAWKINS, A VICE-PRESIDENT OF THE SOCIETY, IN THE CHAIR.

FORTY-SIX MEMBERS WERE PRESENT

In the absence of the President, Dr. Sálim Ali proposed and Mr. G. V. Bedekar seconded that Mr. R. E. Hawkins, a Vice-President of the Society, should take the chair. Mr. Hawkins then took the chair.

At the outset, Mr. Humayun Abdulali stated that there were inaccuracies in the minutes of the Annual General Meeting for 1971 as printed in the Journal and asked whether it was permissible to ask for correction. The Chairman ruled in the negative. The Chairman then asked the Honorary Secretary to present the Report for the year 1971.

The Honorary Secretary said that he would start by referring to the membership of the Society, as he had been doing for the past several years because this was a matter of great importance. He stated that on the day of the Meeting 1,143 members had paid their subscription for the current year, and this showed a slight improvement over the previous year's total of 1,049. There was no room for complacency however, and efforts should be continued to enrol more members.

One of the problems of the Society was the difficulty of keeping in close touch with members outside Bombay. A possible solution was to open branches in various places, and a Bihar Branch of the Society would shortly be opened, and both the Governor of Bihar, Dr. D. K. Borooah, and the Chief Conservator of Forests, Shri S. P. Shahi, would be closely associated with the working of this branch.

In reference to the increasing cost of printing the Society's Journal, the Honorary Secretary said he would particularly like to thank again the Seth Purshottamdas Thakoredas & Divaliba Charitable Trust for their grant of Rs. 15,000 to meet the cost of printing the text and reproducing the photographs of Mr. M. Krishnan's Report on the Mammals of peninsular India.

(1) The Honorary Secretary concluded by saying that he would be glad to answer any question relating to the cyclostyled Report which members might wish to ask. A number of questions were asked by Mr. Humayun Abdulali and Dr. P. J. Deoras seeking clarification in relation *inter alia* to the membership, the printing of Mr. M. Krishnan's Report, and the lack of adequate grants from the Central Government for the Journal necessitating the reduction in size of the Journal in future to 200 pages as mentioned in the Honorary Secretary's Report. The Honorary Secretary explained that the figures of membership were

now based on actual payment of the subscription whereas the figures in earlier years had included the names of many members in arrears. He also said that efforts were being made to raise additional funds to meet the rising costs of printing the Journal. The report was put to the vote and adopted by a large majority, only 6 persons voting against.

(2) The Chairman then asked the Honorary Treasurer to place the statement of accounts before the Meeting. The Honorary Treasurer explained that the deficit of Rs. 11,541·23 shown in the accounts was actually reduced to Rs. 1,541·23 since after the closing of the accounts on 31st December, 1971, the grant from the Government of India of Rs. 10,000 for the Journal had been received. Several questions were asked by members regarding the assets of the Society, the amount of contributions under the heading of administrative charges credited to the Society from the various project accounts, and the increase in postage and telephone charges. The Honorary Treasurer answered the various questions that were raised.

Attention was also drawn to an earlier undertaking naming the Vertebrate Zoology Field Work Fund as the Charles McCann Field Work Fund. The Honorary Treasurer assured the Meeting that he would look into the records and take appropriate action. The accounts were then put to the vote, and were adopted by a large majority, only 3 persons voting against.

(3) The Chairman stated that, no nominations for ordinary membership of the Executive Committee for 1972-73 having been received in addition to the persons recommended by the Executive Committee, the Executive and Advisory Committees for 1972-73 will stand as recommended by the Executive Committee, namely :

President :

Mr. Sumant Moolgaokar.

Vice-Presidents :

Dr. Sálim Ali, D.SC., F.N.A.
Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.)

Executive Committee :

Dr. S. R. Amladi, M.D.
Prof. P. V. Bole
Dr. E. B. Fanibunda, F.D.S.R.C.S. (Eng.), F.R.P.S.
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday.
Mr. B. B. Paymaster, I.C.S. (Retd.)
Mr. G. S. Ranganathan

Mr. D. E. Reuben, I.C.S. (Retd.)
Mr. Sandip Thakore
Dr. C. V. Kulkarni, M.Sc. Ph.D. (Jt. Hon. Secretary)
Mr. Zafar Futehally (Hon. Secretary)
Mr. J. D. Kapadia, I.C.S. (Retd.) (Hon. Treasurer)
Secretary, Ministry of Education, Govt. of India

Advisory Committee :

Mr. H. G. Acharya	*Ahmedabad.*
Mrs. Jamal Ara	*Ranchi.*
Mr. F. C. Badhwar, O.B.E.	*New Delhi.*
Dr. Chintaman Deshmukh, I.C.S. (Retd.) ..	*Hyderabad.*
Mr. M. Krishnan	*Madras.*
Mr. S. Chaudhuri	*Calcutta.*
Mr. Duleep Matthai	*New Delhi.*
Dr. A. P. Kapur	*Calcutta.*
Mr. Ranjit Sinh, I.A.S.	*New Delhi.*

(4) The Chairman said that written notice of 5 resolutions had been received ; one proposed by Dr. P. J. Deoras and seconded by Mr. Humayun Abdulali, and the other four proposed by Mr. Humayun Abdulali and seconded by Dr. P. J. Deoras. The Chairman asked Dr. Deoras to move his Resolution.

Dr. Deoras then read the first Resolution which was as follows :

> Considering the statements and counter-statements made at the last Annual General Meeting of the Bombay Natural History Society, and subsequently, it is resolved that a committee of 3 persons (including not more than one person on the present Committee) be appointed from among members resident in Bombay to consider and report on the following :
>
> (1) If the reference collections have been suitably maintained and worked upon.
>
> (2) If the funds made available by the Government of Maharastra have or have not been utilised in accordance with the terms of the grant.
>
> (3) If the membership and other interests of the Society have suffered due to the clubbing of interests with other independent organisations in which the Honorary Secretary is interested.
>
> The Committee shall receive and invite evidence from members, or any other source, and submit a report within 3 months and which report is to be circulated to all members resident in India. Thereafter if required by any member, a general meeting of the Committee is to

be held within 30 days to decide what action, if any, is to be taken.

Speaking on the Resolution Dr. Deoras said that there was considerable misgiving among some members about the fact that the Honorary Secretary of the Society was the Secretary of World Wildlife—India and it was possible that under the circumstances the Society's interests were neglected, and even suffered because of the competing interests of the two bodies. He said that if a committee of three persons was appointed to go into the question it would help to clarify matters.

Seconding this Resolution Mr. Humayun Abdulali elaborated on various aspects of the Society's working including the low membership, the neglect of the Reference Collections, the use of research staff meant for the Reference Collections in the field[1], and the connection which the Honorary Secretary had with World Wildlife—India and the Birdwatchers' Field Club of India. He stated that in the early sixties there were almost 1218 members so that the membership in fact had declined. He complained that more publicity was given to World Wildlife—India even in projects like the Gir Project which was principally undertaken by the Society.

The Honorary Secretary replying to these criticisms said that as far as the membership was concerned it was only recently that the records were brought up to date, and the figures presented today were on the basis of members in good standing. The records of previous years were totalled up including even those members who were in arrears for several years. Regarding the Gir Project he said that adequate publicity had been given to the Bombay Natural History Society wherever appropriate, but in fact the World Wildlife Fund had given the original grant which enabled the researchers to come to India. It was, therefore, only proper for the World Wildlife Fund to be given full credit for this. With regard to the activities of World Wildlife—India, the Honorary Secretary explained that instead of posing a threat to the Society as alleged, it was engaged in projects which the BNHS should welcome. For example, a sum of Rs. 20,000 was made available by the World Wildlife Fund to the Bombay Natural History Society for publication of a booklet on nature, and a sum of Rs. 1,79,000 was being given to the Maharashtra Government for extending the Borivli National Park, a project in which the BNHS was deeply interested. All the other grants made by WWF in India were in consonance with the thinking and approach of the Society.

Mr. S. P. Shahi, Chief Conservator of Forests, Bihar, said that in his view it was a great advantage for BNHS to have close links with

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[1] Mr. Humayun Abdulali points out that his objection was not to the use of the research staff in the field, but to their use for work not associated with the Reference Collections.

WWF, and the fact that the Honorary Secretary of the Society was also the Honorary Secretary of the WWF should be welcomed. He said it would be most unfortunate if this Resolution was accepted because apart from the fact that it was quite unnecessary to appoint a committee of enquiry, it would also create an unfortunate impression amongst out-of-station members about a division in the ranks of the Society. The BNHS was an all-India body of great standing, and if the Resolution was passed it might recoil against its own interests. He, therefore, appealed to the members to reject the Resolution.

Mr. G. V. Bedekar said that the Executive Committee had gone deeply into the question of the Reference Collections, and was unanimously of the view that they were maintained satisfactorily, taking into account the nature of the facilities and finance available to the Society. The fact that occasionally members of the research section were sent out into the field was a desirable move because it enabled the staff concerned to get better acquainted with the specimens they were handling in the collections. He said that there was no question of the funds having been misapplied, and it was most regrettable that such a serious charge should have been made so lightly by the Proposer and the Seconder of this Resolution. With regard to the connections between the BNHS and the WWF it was the considered view of the Executive Committee that the interests of the two bodies were complementary and not conflicting, and all facilities offered by the BNHS to outside institutions had always been fully paid for. He said that he was unable to understand what was meant in the Resolution by the statement at the end that 'a general meeting of the Committee is to be held within 30 days'. He requested the members to throw out this unnecessary and ill-conceived Resolution. The Proposer and the Seconder had not even specified the names of the three persons of the enquiry committee.

Speaking on the Resolution, Dr. C. V. Kulkarni said that he had experience of reference collections abroad, and confirmed what Mr. Bedekar has stated that by and large the Society's collections were well maintained. There were some mistakes in the place names in the catalogue, which were being rectified. There was no need for any special enquiry committee as suggested by the Resolution, and he said he would like the Resolution to be rejected.

In his reply, the Proposer suggested that Mr. B. B. Paymaster, Mr. Amarnath A. Dikshit and Mr. B. V. Rangnekar could be asked to act on this committee. To the Chairman's question whether the consent of these three gentlemen had been obtained, Mr. Paymaster who was present indicated his unwillingness to serve on the committee; Mr. Dikshit who was present said that he would be willing provided the general body wanted him to serve; and with regard to

Mr. Rangnekar it was evident that he had not been consulted and in fact he was not even a member of the Society.

The Chairman then put the Resolution to the vote, and it was defeated, only 6 persons voting in favour of it.

The Chairman then asked Mr. Abdulali to place the other Resolutions before the meeting, and the following three Resolutions were accepted:

(1) That when members of the public or of any other society are invited to any of the functions of the Bombay Natural History Society, the Honorary Secretary or some other persons should make a statement inviting all those who are not already members to join the BNHS and to lend it their support.

(2) That as and when the Hon. Secretary is away from town and somebody else is acting in his place, a notice to this effect should be put up on the notice-board.

(3) That a board should be placed at the entrance at the foot of the stairs to show which, if any, of the officers of the Society is present.

The fourth Resolution, 'That the offices of the Society should remain open to weekdays up to 5-30 p.m.; also on all Saturday afternoons', was withdrawn after it had been pointed out that the Society's staff could not be expected to work for longer hours than the Government of Maharashtra's staff, and that with previous notice arrangements could usually be made for research work to be carried on in the Society's premises outside office hours.

The meeting terminated with a vote of thanks to the Chair.

R. E. HAWKINS,
15-9-1972.

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